UNCLASSIFIED

AD NUMBER
AD901900
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; 05 MAY 1972. Other requests shall be referred to Assistant Chief of Staff for Force Development (Army), Attn: FOR-DS-CSS, Washington, D. C. 20310.**
AUTHORITY
HQ DA Notice dtd 30 Aug 1974

THIS PAGE IS UNCLASSIFIED

Tactical Vehicle Pooling in the Corps/Army Service Area

by Charles A. Allen
Bryce A. Frey
John W. Rakowski
Richard C. Rinkel, Project Director

Copy 34 of 130

RAC Research Analysis Corporation

Tactical Vehicle Pooling in the Corps/Army Service Area

by

Charles A. Allen
Bryce A. Frey
John W. Rakowski
Richard C. Rinkel, Project Director

Research Analysis Corporation RAC

McLean, Virginia 22101

Area Code 703
893-5900

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

DARD-ARG-S

1. RAC document "Tactical Vehicle Pooling in the Corps/Army Service Area" was prepared by the Research Analysis Corporation for the Office of the Assistant Chief of Staff for Force Development. This document is a product of RAC study 011.156 (Task Order 71-16, DAHC19-69-C-0017).

2. The Army is continually faced with the dual problem of determining its tactical vehicle requirements and simultaneously minimizing prohibitive acquisition and operation and maintenance costs. The concept of pooling has always been suggested as a means to offer potential savings without degrading operational effectiveness. Accordingly the Research Analysis Corporation conducted a study (Phase I) to analyze the pooling of vehicles authorized in a type Infantry Division (April 1971). since this study indicated that potential savings could be made by pooling, it was decided to examine vehicle assets in a type Field Army where bigger savings might accrue by pooling. The purpose of the attached study (Phase II) entitled "Tactical Vehicle Pooling in the Corps/Army Service Area" was to identify those vehicle tasks which developed in the "Phase I" study, to analyze selected pooling problems, to provide a system for introducing the alternative developed into the 'REVAL-WHEELS' computer model, and to examine the concept of containerization.

3. When considering fleet costs, potential savings, and indeed the totality of the study results certain perspectives must be maintained. Although a great deal of effort has been expended in the collection of the most accurate data available concerning organization and use of the current vehicle fleet, and while the model used appears to accurately simulate the current vehicle system and the alternative pooling schemes developed, there is one factor which was not addressed - this is the command and control factor which looms as a potential deterrent to the apparent pooling advantages. Therefore the pooling concept is one which must be proved by field test in order to formulate firm recommendations on vehicle reductions. In addition the vehicle authorizations addressed in the study are those prior to the vehicle reductions recommended by the Tactical Vehicle Review Board (TVRB), a report by CDC approved by DA on 28 February 1972, and the reductions recommended by the ongoing 'WHEELS'

Published July 1972
by
RESEARCH ANALYSIS CORPORATION
McLean, Virginia 22101

RAC

Study Group. These two efforts will cause the tactical wheeled vehicle authorizations to be reduced approximately 30%. In view of the above the pooling concept would have to be reexamined.

4. The findings of this document are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

LEWIS W. WRIGHT, III
LTC, GS
Acting Chief, Research Support Division

FOREWORD

This study, prepared by the Research Analysis Corporation for the Assistant Chief of Staff for Force Development, refines methods previously developed in RAC Study 010.128 "Analysis of Opportunities for the Reduction of Tactical Vehicle Requirements through Pooling" and applies them to analysis of tactical vehicle pooling within the units and organizations of the corps/army service area. Although the main research effort has been methodological, the models derived were validated through formulation and solution of several typical vehicle pooling problems using current Army vehicles, units, and doctrine. The solution of these problems indicates that substantial vehicle and cost savings may be realized through vehicle pooling.

This study, together with RAC Study 010.128, provides Army vehicle fleet planners with a set of flexible, precise tools for use in analysis of vehicle requirements and organizational alternatives for vehicle usage.

J. ROSS HEVERLY
Vice President
Technological Systems Group

CONTENTS

RAC

Appendixes

Figures

Figures (Cont'd.)

Figures (Cont'd.)

Tables

EXECUTIVE SUMMARY

PURPOSE AND OBJECTIVES

The purpose of this study and of the previous RAC Study 010.128, "Analysis of Opportunities for Reduction of Tactical Vehicle Requirements through Pooling," was to develop methods to analyze the concept of pooling tactical vehicles and to apply them to the solution of specific problems. The analysis emphasized potential vehicle savings and the comparison of pooled fleet performance with the performance of the fleet as currently organized.

The specific objectives of both studies were:

> Identify and categorize tactical vehicle pooling opportunities within a type infantry division and within the units and organizations in the corps/army service area of a deployed field Army.
>
> Develop methods of analysis and apply them in the solution of selected pooling problems.

STUDY APPROACH

In both studies research was undertaken in two phases. A preliminary analysis phase developed a data base for the fleets involved and surveyed these fleets to determine which vehicle tasks and associated vehicle assets indicated the most potential vehicle savings through pooling. The primary criteria used in this preliminary analysis were the number of assets engaged in specific tasks, e.g. cargo transport, and the nature of the task with respect to such factors as response time required for task performance.

The second analysis phase was the development of a vehicle fleet performance simulation, and its application to the analysis of the performance of both the pooled fleet alternatives and the fleet as currently organized.

STUDY RESULTS

Selected Pooling Problems

In the preliminary analysis phase of each study certain tasks were isolated which appeared most promising for pooling analysis. At the division level these tasks were:

- Cargo transport
- Bulk fuel transport
- Maintenance vehicle operations
- Ambulance operations

At the corps/army service level the same tasks were selected except for the exclusion of ambulance operations. The issue of containerizing certain loads and pooling vehicle chassis (container carriers) was addressed in the corps/army level study.

Pooling Analysis Results

The results of the pooling analysis for the selected tasks are presented here in the briefest possible form. The vehicle organizations (pooled and current) and task performance demands which led to these results are included in the full study reports. It must be remembered when considering the results shown here that while considerable effort was expended in data validation and in making the simulation process as realistic as possible, all results were meant to serve as planning guides and indicators. Actual implementation of the pooling concept by way of changes in doctrine and tables of organization and equipment should be undertaken only after field tests in each case.

In the division level pooling analysis it was found that:

1. Cargo and bulk fuel transport missions under peak combat demand conditions can be handled by pooled fleet alternatives with a performance that is comparable to that of the current fleet. These pooled fleet alternatives allow a 25 to 35 percent reduction in vehicle numbers and a savings per division of 18 to 28 million dollars over the life cycle of the fleet.

2. Pooling of a portion of the vehicles performing maintenance operations within the division area can result in vehicle savings of 20 to 30 percent while providing services comparable to the current fleet.

Fleet cost savings per division would range from 3.5 to 3.7 million dollars (including driver costs) over the fleet life cycle.

3. Analysis of several alternative pooling organizations for ambulance operations showed that there was no pooling alternative which provided greater responsiveness to casualty evacuation demands. In fact any fleet reduction resulted in a degradation of service. These results were primarily due to the quick response times required for casualty evacuation missions.

The results of pooling analysis in the corps/army service area can be summarized as follows:

4. Pooling of cargo vehicles within a corp support group area of operations resulted in fleet performance comparable to current fleet performance for pooled fleets of 50 to 55 percent the size of current fleets. The pooled fleet alternatives could result in cost savings of from 31 to 40 million (31 to 39 percent) dollars per corps support group over the life-cycle of the fleet.

5. A portion of the tanker fleet within the corps support group area was pooled while leaving sufficient tankers with units to meet the need for mobile fuel storage. The resulting tanker fleet could be reduced by the equivalent of 20 to 25 percent of the total tanker fleet while maintaining task performance at current levels. This fleet reduction could result in 8 million dollars of life-cycle cost savings per corps support group.

6. Analysis of pooled maintenance vehicle fleet operations showed potential savings of approximately 40 percent in fleet size and 9 million dollars in life cycle costs per corps support group without a reduction in current fleet performance.

7. Containerization of certain loads now carried by vehicles with integral bodies and subsequent pooling of vehicle chassis indicated that a pooled chassis fleet of 50 percent of the vehicles selected could provide adequate container movement on demand. However, the potential cost savings in vehicle chassis were more than overcome by the additional driver costs incurred by the pooling scheme. This was due to the fact that almost none of the vehicles involved have assigned drivers under current organization while all pooled chassis (container carriers) would require at least one full time driver.

This summary of results of the two studies on tactical vehicle pooling indicates important vehicle and cost savings through pooling. However, the most significant result of the studies was the development of a simulation model which can rapidly assess the results of alternative vehicle organization and operational schemes against a background of varying demands for vehicle services.

SUMMARY

PURPOSE AND OBJECTIVES

The purpose of this study is to investigate the concept of tactical vehicle pooling in the organizational and operational context of a deployed field army. Emphasis is upon refinement of methods developed in previous work and their application to specific pooling problems in the corps/army service areas. The analysis of these problems is designed to exhibit the potential of the methods for determining the performance risks and benefits as well as for determining the cost implications of using pooled alternatives to current vehicle fleet organization.

Specific objectives of the study are:

> Identify and categorize tactical vehicle pooling opportunities within the units and associated vehicle assets of a deployed type field army.
>
> Extend and refine methods of analysis of vehicle pooling previously developed, and apply the refined methods to selected field army pooling problems.
>
> Provide an automated system for the introduction of pooled vehicle fleet alternatives into the ACSFOR REVAL WHEELS fleet planning method.

BACKGROUND AND SCOPE

This study is a direct follow-on effort to RAC Study 010.128, "Analysis of Opportunities for the Reduction of Tactical Vehicle Requirements Through Pooling."[7] In this previous study the concept of tactical vehicle pooling as a fleet planning alternative to the traditional TOE method of structuring vehicle fleets was investigated at the division level of Army organization. Tactical vehicle pooling

opportunities within a type infantry division were isolated, analytical methods (vehicle fleet performance simulations) developed to investigate these pooling problems, and several example problems were investigated in detail. The results of this study indicated considerable vehicle savings through pooling in the tasks of cargo and bulk fuel transport and maintenance vehicle operations. The discrete pooled fleet sizes and associated cost savings produced were subject, of course, to the validity of input data available for analysis and should be viewed with caution. Overall, however, the study showed the development and testing of a flexible, easy to use method for comparing the performance of alternative tactical vehicle fleet organizational concepts.

The scope and character of the present study is somewhat different from the previous work. Emphasis is on fleet organization of combat support and service support units at the corps and army service area level. Thus a much broader spectrum of unit types and a much greater geographic area is considered than was the case with the previous study. On the other hand, variation in mission demand for tactical vehicle services is somewhat reduced in comparison to the division level study since corps and army area unit demands fluctuate less as a function of combat posture.

VEHICLE POOLING - AN OPERATIONAL DEFINITION

Discussion of vehicle pooling, especially of vehicles in support of combat operations, results in a multitude of definitions, considerations, and factors which influence the problem. The demand for vehicle services, the responsiveness of the vehicle fleet, and the costs involved are subject to conflicting points of view on the part of operational personnel and fleet planners. Rather than consider the problem from these viewpoints and to try, prior to analysis, to account for many viewpoints, the study group decided very quickly to adopt a workable, operational definition of vehicle pooling as follows:

> Vehicle pooling consists of the aggregation in centralized locations and under centralized administration of vehicles formerly dispersed physically and/or organizationally throughout using units. These centralized pools of vehicles are then to be used in the performance of the task(s) formerly performed by the dispersed vehicles.

Implicit in this definition is, of course, the restructuring of vehicle fleets not only in location and administration, but in size and in the vehicle types which make up the fleets.

STUDY APPROACH

The approach to tactical vehicle pooling analysis taken in this study was as follows. A type field army organization and its geographic deployment in a combat situation were obtained for use as a framework for finding tactical vehicle pooling opportunities. The tasks and associated vehicles of the units included in the field army were then extracted from the task data tape of the REVAL WHEELS [1] fleet planning model. These data were then analyzed for tasks in which vehicle pooling appeared feasible.

Having found potential vehicle pooling opportunities, a combat scenario was selected to form a basis of mission demands for tactical vehicle services in each of the selected tasks. Alternative, pooled vehicle fleets were formulated for comparison with the current fleet in satisfying the mission demands generated by the combat scenario. Vehicle fleet performance comparisons were then made using the simulation methods described in Chapter 1 and Appendix A, and current versus pooled fleet cost comparisons were made where appropriate.

DETERMINATION OF VEHICLE POOLING OPPORTUNITIES

The approach to finding potential vehicle pooling opportunities considered two primary factors, the number of vehicles in the field army engaged in a given type of task, and the nature of the task itself with respect to the feasibility of using pooled rather than user unit organic vehicles in task performance.

Figure S-1 shows in bar chart form the percentages of total field army tactical vehicle assets (50,359 vehicles) engaged in each of the 24 task types defined by REVAL WHEELS. As shown, over 85% of the vehicles are engaged in commander and staff transport, commo/electronics facilities transport, cargo, bulk fuel, and engineer equipment transport, and in service support tasks. It is within these task-vehicle asset combinations that the maximum potential for vehicle pooling would be expected from the standpoint of sheer vehicle numbers.

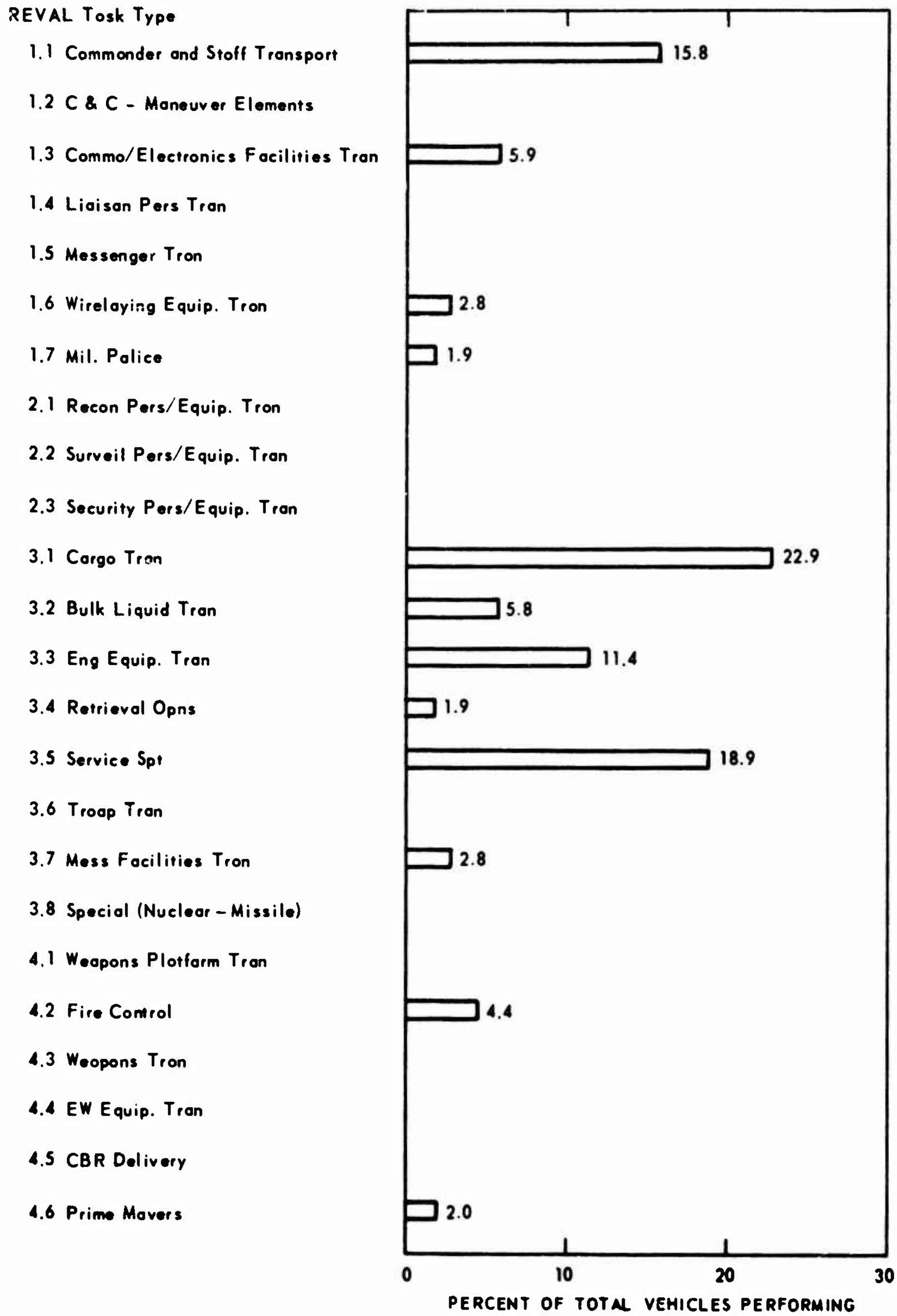


Fig. S-1—Field Army Tactical Vehicles (No Divisional Forces)

Total vehicles = 50,359.

Investigation of the nature of these tasks, however, reveals strong constraints on vehicle pooling in several cases. For example, the vehicles engaged in transport of communications/electronics facilities cannot be pooled unless the equipment carried is containerized and off-loaded at the using unit's location since the continuous presence of the equipment is necessary for effective unit performance. Similar constraints are present in consideration of pooling engineer equipment transport vehicles.

For different reasons, the feasibility of pooling commander and staff transport vehicles is doubtful. Although these vehicles may not be in continuous use, the very short response times required when their use is necessary and the unpredictable duration of the missions they perform militates against removing them from the using unit.

Unlike those task-vehicle asset combinations just discussed, the vehicles transporting cargo, bulk fuel, and those performing maintenance operations are engaged in specific, well defined tasks which do not require the continuous presence of the vehicles involved at the user unit locations. It is in these three tasks that vehicle pooling appears most feasible and which, in addition to addressing containerization of certain vehicle loads in other tasks, are the subject of detailed analysis.

ORGANIZATIONAL AND GEOGRAPHIC CONSTRAINTS

In addition to numbers of vehicles and task types, other factors affecting the feasibility of vehicle pooling must be taken into account. For example, the pooling of all the cargo trucks within a type field army would result in a huge pool of vehicles difficult to command and control, would generate mission radii of excessive length to the units served, and would cut across organizational and doctrinal lines already established for the smooth operation of combat service support.

A more logical approach was to consider the pooling of cargo, tanker, and maintenance vehicles within the areas of control of already established service support organizations such as a support group area within a corps or army support brigade. Vehicle pooling within a support group area not only permits realistic mission radii for vehicle groups serving units from a central pool, but provides a comprehensive analytical framework. This is because almost all combat service support (with the

exception of line-haul operations) in the corps and army service areas of a deployed field army is provided by such support groups.

THE COMBAT SCENARIO

In addition to the selection of an appropriate organizational framework within the type field army, application of the pooling methodologies developed require the use of specific data including unit locations of a deployed field army. At least a general scenario of the combat situation in which the army is engaged is also needed. These data are required since not only the movement of cargo and bulk fuel and the operations of maintenance vehicles in both the fleet as currently organized and by pooled fleets are to be analyzed, but the impact of vehicle pooling upon unit mobility must be considered. Unit movement rates as well as re-supply and maintenance demands require general scenario information in keeping with the overall assumptions of the study. The only scenario information of this type available and concerned primarily with combat service support units is that used by the LOGEX studies conducted at Ft. Lee, Virginia. This scenario is described in Chapter 2.

ANALYSIS OF SELECTED POOLING PROBLEMS

Introduction

In each vehicle pooling problem selected for analysis, the performance of the fleet as currently organized was compared with the performance of pooled fleet alternatives by means of the simulation methods developed in previous work and refined in this study. Since these simulation methods are already well documented,[7] they will not be discussed in this summary, however documentation is provided in Chapter 1 and Appendix A. The core of the simulation methods employed is the ability to arrive at fleet performance measures for alternative fleet organizations, all of which have been subject to common levels of vehicle mission demand indicated by the combat scenario used.

Cargo Vehicle Pooling

The analysis of pooling those vehicles designated by the REVAL WHEELS system as performing cargo transport (task 3.1) consisted of specifying the current cargo vehicle fleet and its operations and then formulating pooled alternative fleets for fleet performance and cost comparisons.

Current and Pooled Fleet Alternatives. As shown in Chapter 3, there are a total of 1763 truck/trailer combinations organic to units in the corps support area chosen. Not all of these vehicles are available for pooling however, since the vehicles belonging to line-haul transportation units are totally engaged in hauling cargo forward into (and through) the corps service area. In addition the M548 ammunition carriers assigned to corps artillery units are used almost exclusively to haul ammunition from the battalion trains areas to the firing batteries.

When the vehicles noted above are deleted from the total cargo transport fleet, 1119 vehicles ranging in size from 3/4 ton to 5 ton cargo trucks with trailers remain for use by the current (user unit organic) fleet in area service cargo missions. It is this current fleet which is contrasted with pooled fleet alternatives in the fleet performance analyses. These pooled fleet alternatives consist of straight percentage reductions by vehicle type to 60, 50, 40, and 30% of the current fleet size, and in addition a remixed pooled fleet alternative. This latter fleet's composition by vehicle type is based on mission-vehicle payload matching for typical peak cargo demand days in the combat scenario.

Mission Demands and Fleet Operations. Mission demands on the cargo fleets, pooled or current, are of two basic types: delivery of needed cargo resupply to using units, and unit move assistance. The resupply tonnages required on a daily basis for each of the using units in the support group area were derived from data in the LOGALOC II Study[5] and from the Armed Forces Planning Guide-Europe.[6] Unit move missions were based on the assumption that in the current fleet all cargo trucks are utilized up to their rated payload in carrying unit equipment and supply reserves in a unit move and that the pooled fleet alternatives must furnish this same capability to a unit when a move is necessary. The frequency of unit moves was based on the rate of FEBA movement in the combat scenario used.

Fleet operations of the current cargo fleet consist basically of unit vehicles traveling to supply points, loading the necessary resupply and returning to the unit and unloading. For unit moves, the necessary

equipment and supply reserves are simply loaded on cargo vehicles, transported to the new unit location and unloaded. The pooled cargo fleet alternatives on the other hand, operate outward from a central vehicle pool location in the corps service area and deliver needed resupply as requested by the using units. Unit move assistance is also performed by travel outward to the user unit where the necessary load is picked up and transported to the new unit location.

Cargo Vehicle Fleet Performance Simulation. Based on the cargo fleet alternatives, mission demands, and fleet operations just described, the performance of each alternative fleet was simulated over the 15-day LOGEX 71 combat scenario. The results of these fleet performance simulations are discussed in detail in Chapter 3 and are given here only in summary form as shown in Figs. S-2 and S-3.

These two figures give the simulated performance of the current and pooled fleet alternatives in the form of cumulative mission delay and mission completion time curves aggregated over all basic cargo mission types; ammunition resupply, other cargo resupply, and unit move missions.

As seen in Fig. S-2, the cargo fleet as currently organized suffers few mission delays with 95% of all missions dispatched with no delay. Those missions delayed, however, are delayed as long as 7 hours. Among the pooled fleet alternatives, the 60% pooled fleet shows no mission dispatch delays, while the pooled 50% fleet (linear decrement by vehicle type) and the fleet remix provide mission delay performance slightly worse than that of the current fleet. These two alternatives dispatch over 85% of all missions with no mission delay and all missions are dispatched in 6 hours or less.

A more important fleet performance parameter from the viewpoint of units requiring vehicle services is that shown in Fig. S-3, mission completion time. It is this measure of performance which defines the total response of the fleets to requested cargo vehicle services. Mission completion time is defined as time from mission request to delivery of cargo to the using units.

Although the mission completion time curves very greatly in shape between the current fleet and the pooled fleets, the 50% pooled fleet

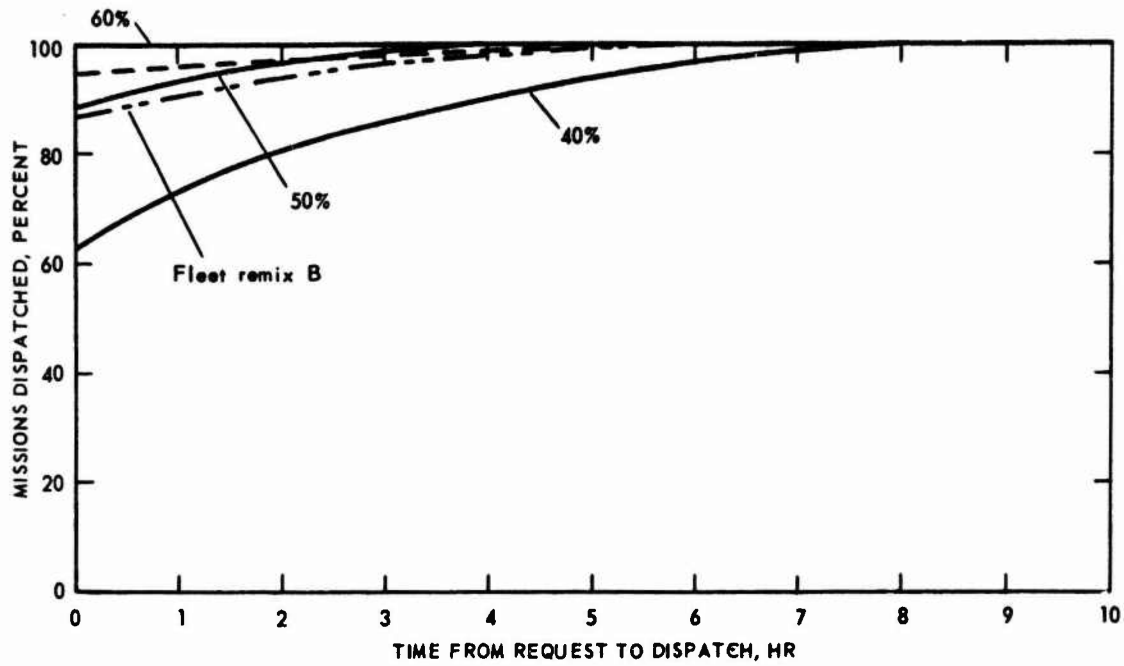


Fig. S-2—Cumulative Mission Dispatch Times—All Mission Types

Heavy unit move payloads.

— — — Current fleet ——— Pooled fleet

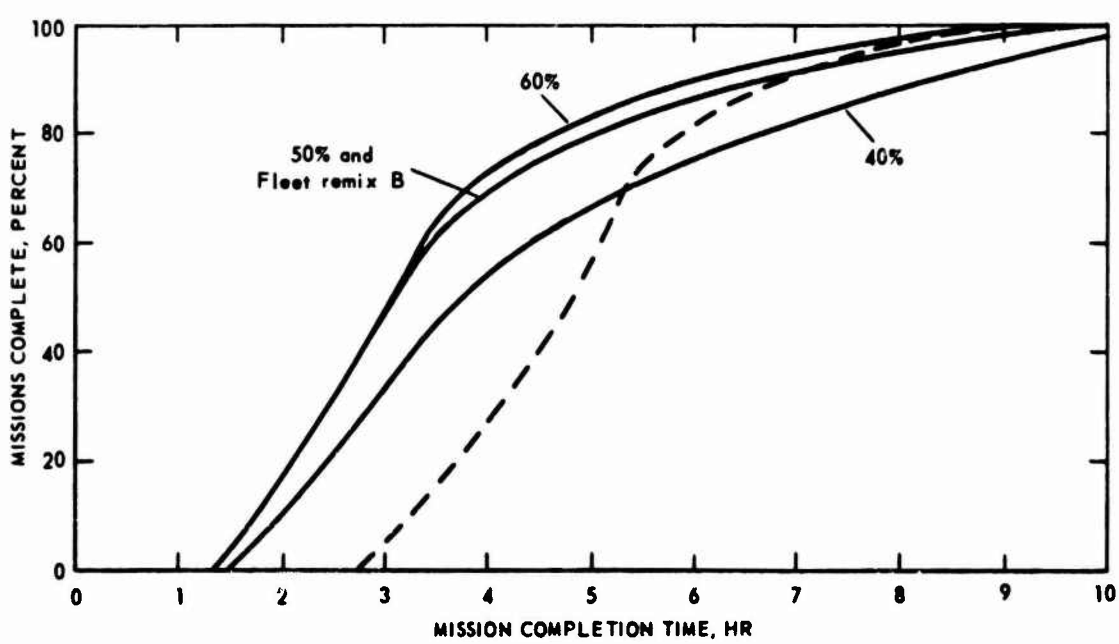


Fig. S-3—Cumulative Mission Completion Times—All Mission Types

— — — Current fleet ——— Pooled fleet

and the fleet remix provided performance most closely matching that of the current fleet. For all three of these fleets over 90% of all missions are completed in 7 hours or less from time of request and all missions are completed in 10 hours or less. The current fleet organization, however, does not provide as many completed missions in the zero to six hour range.

The difference in the mission completion time curves between the current and pooled fleet alternatives is fully discussed in Chapter 3. This difference is caused by the inclusion of return travel time from the supply point to the user unit in mission completion time for current fleet operations while pooled fleet cargo resupply missions are complete upon delivery and unloading of requested supplies. Return travel time, while contributing overall to vehicle unavailability for missions to other units, does not enter into the time necessary to deliver supplies using the pooled fleet organization.

Current and Pooled Vehicle Fleet Cost Comparison. On the basis of performance results presented in the preceding section, example cost comparisons between the cargo fleet as currently organized and the pooled fleet remix and 50% pooled fleet were prepared. It should be cautioned that the cost comparisons shown are based on the best data available, but can only be considered as examples of the magnitude of cost savings to be expected if the data and assumptions of the study are correct. As with the performance analysis conducted, the cost results of this study are intended only to indicate the capabilities of the models developed.

Total vehicle costs (12-year life cycle) for the current, fleet remix, and 50% pooled fleet are 41.7, 20.1, and 20.8 million dollars respectively.* Thus the vehicle costs of the two pooled fleet alternatives are just less than half the vehicle costs of the current fleet.

It is the driver costs which dominate the cost comparisons however. The REVAL WHEELS study costs assigned drivers at $8600 per year and additional duty (part-time) drivers at $1000 per year. On this basis the current fleet with 507 assigned drivers and 612 part-time

*See Table 3-9, p 3-42.

drivers has a total 12 year life cycle driver cost of $59.6 million.

Driver costs for the pooled fleet alternatives are problematical. It is difficult to determine the ratio of full time drivers to vehicles on the basis of a two-shift 20-hour operating day. Based on calculations involving vehicle availability and operating hours,* a ratio of between 1.1 and 1.2 drivers per vehicle was determined. The total cost comparison shown in Fig.S-4 covers driver/vehicle ratios ranging from 1.0 to 1.5. This figure shows total fleet costs (drivers and vehicles) for both pooled fleet alternatives and the current fleet, and indicates that total cargo fleet cost savings of as great as $31 million could be possible using a 1.2:1 driver to vehicle ratio or as much as 40 million dollars with a 1.1:1 ratio. These figures represent savings of 31 and 39% respectively of current fleet total costs. Figure S-4 also shows a current fleet total cost with additional duty drivers costed at $4300 per year. This amounts to assuming that such drivers are occupied one-half time in vehicle operation. If this is a more realistic assumption than that used by REVAL WHEELS, total fleet cost savings would be about $24 million greater than those indicated above.

Pooling of Tanker Vehicles

Introduction. Pooling of tanker vehicles required a different approach than that used in the analysis of cargo vehicle pooling. The difference stemmed from the fact that many of the tanker assets (approximately 25 percent) are already pooled under current fleet organization in the petroleum supply and supply and service companies. In addition, those vehicles not pooled in this manner engage in the triple missions of fuel resupply from supply points, mobile filling station activities at the user unit location, and as fuel storage tanks.

To eliminate or reduce the multiple types of missions just described and thus free additional tankers for possible pooling depends upon very responsive fuel resupply by the tankers already pooled and possible alternate means of fuel storage at user units such as collapsible fabric drums.

Analytical Approach. The approach taken was to simulate the

---

*See Chapter 3, p 3-43.

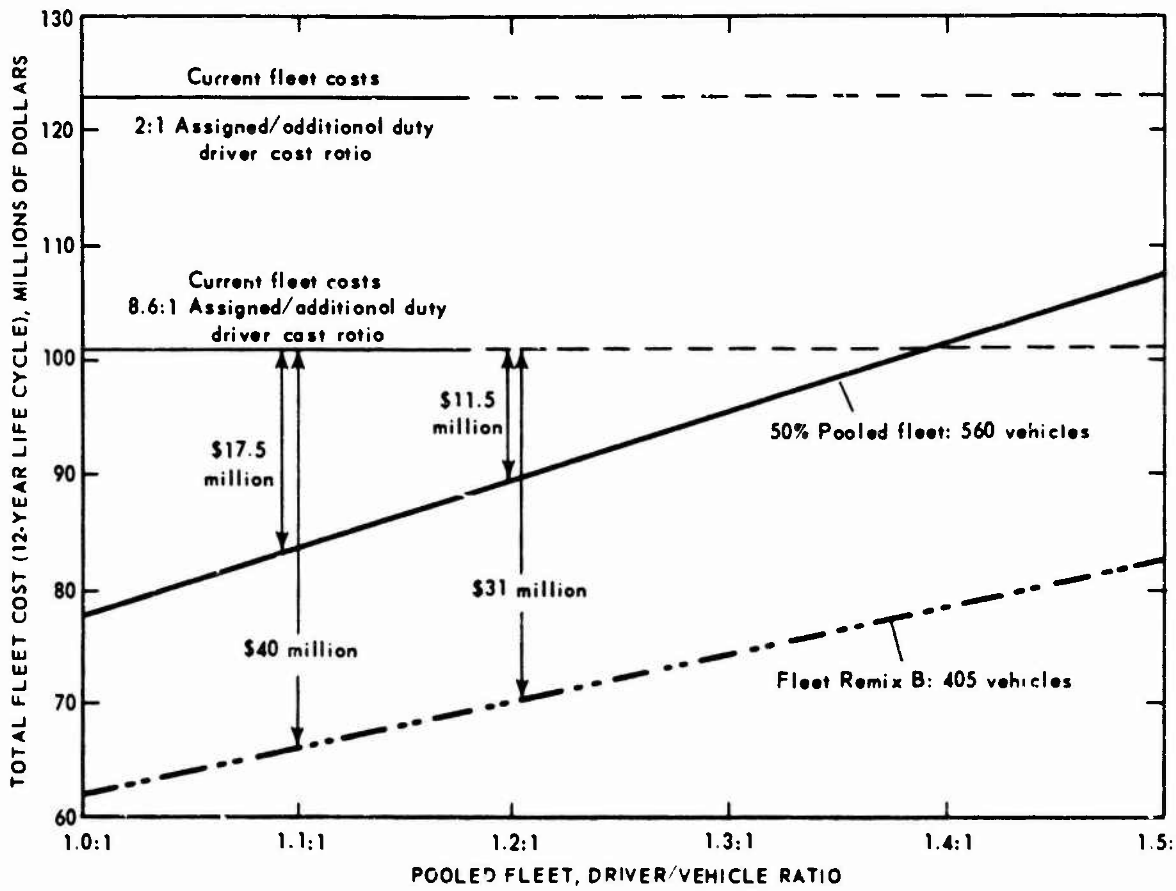


Fig. S-4—Comparative Costs—Current vs Pooled Cargo Fleet Alternatives

performance of those tankers already pooled in the petroleum supply company and supply and service company. The mission demands for this "base case" simulation were based on the same combat scenario used in the cargo fleet analysis. They consisted of daily fuel resupply missions to all of the units in the corps support group area over a period of 7 days in the attack posture and 8 days in support of exploitation by the combat elements of the corps.

Using the same mission demand, the performance of a larger pooled tanker fleet comprising approximately 45 percent of total tanker assets was then simulated. This fleet consisted of the original vehicles plus tankers pooled from each unit in the support group area that had more than one fuel tanker with an assigned driver. All such tankers and drivers were pooled except tankers organic to aviation units which have a very high level of mobile filling station activity.*

Simulation Results. Using the inputs just described the performance of the two alternative pooled tanker fleets was simulated for the scenario. The results of these simulation runs, in terms of mission dispatch delays, are given in Chapter 4 and for mission completion times are shown in Fig. S-5. Mission completion time for bulk fuel resupply missions is defined as time from mission request through unloading of the fuel cargo at the using unit. Return travel time to the pool is not included since from the standpoint of the user unit, the resupply mission is complete on delivery and unloading of the requested fuel. Return travel time does, of course, affect the time availability of vehicles in the pool for assignment to other missions.

The results for the current pooled tanker fleet show mission completion times are fairly responsive with over 95% of all missions completed within 9 hours of a 20-hour work day. With the 45% pooled fleet alternative almost no mission dispatch delays are experienced and the mission completion time distribution approaches the minimum limits imposed by the distributions of travel and load/unload times for the various missions to user units.

---

*A small number of other tankers were not pooled for reasons given in Chapter 4, p 4-5.

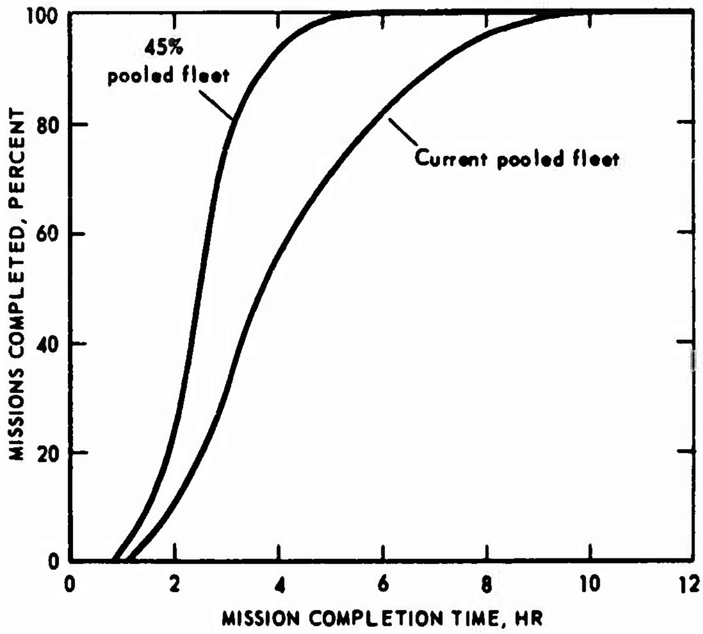


Fig. S-5—Cumulative Mission Completion Times—Bulk Fuel Resupply

Potential Vehicle and Driver Cost Savings. Since definitive tanker fleet performance specifications are not available, analysis of potential fleet reductions on the basis of simulated fleet performance are, of course, strictly hypothetical in nature. If it can be assumed, however, that the performance of the current pooled fleet as shown in Fig. S-5 is acceptable, then it is useful to provide an example of the potential tanker vehicle and driver savings represented by eliminating the difference between the current pooled fleet and the alternative fleet in which 45 percent of available tankers are pooled. These potential savings are shown in Table 4-4, Chapter 4, and amount to over 8 million dollars in a 12-year life-cycle period.

More important than the specific results presented however, is the illustration of the ease of applying the fleet performance simulation developed in this and preceding studies. When fleet performance can be specified and simulation inputs validated, a tested method is available to produce rapid comparisons of conceptualized alternative vehicle fleets. These alternative fleets might include the substitution of collapsible fabric drums for some of the tankers now used primarily for bulk fuel storage. Another possible alternative for future analysis is the pooling of tanker vehicles from tanker/trailer combinations while leaving the trailer mounted tank and pump units with using units. These trailers could then serve as either storage tanks or as mobile filling stations if they were towed by another prime mover from the unit.

Pooled Maintenance Vehicle Operations

The vehicle assets used for maintenance support are contained in the classes that perform retrieval and service support tasks (REVAL WHEELS Tasks 3.4 and 3.5).

The maintenance activity includes organizational, direct support, and general support provided for equipment of the support group units and, in addition, overflow direct support and general support provided for divisional equipment. The analysis consisted of determining the current maintenance vehicle fleet and its operations and then formulating pooled alternative fleets for performance comparison.

Current and Pooled Fleet Alternatives. As shown in Chapter 5, a total of 1774 vehicles in the support group are used for retrieval and

service support. Fifty-five vehicles perform various personnel services and 228 vehicles perform medical services. This leaves 1491 vehicles for maintenance services. Not all of these vehicles are available for pooling.

Vehicles authorized to carry shop sets and the heavy tool kits are considered as self-propelled shop equipment rather than vehicles that respond to transport demands. Another operational class of vehicles is used for parts storage. The majority of this class is the supply van semi-trailers. These parts supply vehicles are assumed to remain with the shop operation in their current organizational unit.

The operations in which maintenance service pooling may be considered are repair parts delivery, contact maintenance/technical assistance, and recovery/evacuation. There are 600 vehicles remaining in these categories and distributed through most of the units in the service area. It is this current fleet which is contrasted with pooled fleet alternatives. These pooled fleet alternatives consist of percentages by vehicle type of 100, 80, 60, 50, and 40% of the current fleet. In the analysis the wrecker fleet was seen to have a relatively poor response to the retrieval missions. Thus a final set of results is presented for a contact maintenance and parts delivery pool only. The wreckers are allowed to remain organic to individual units.

Two pooled alternatives are proposed in order to consider different extents of pooling. In the first, maintenance alternative A, only the maintenance vehicles are pooled. In the second, maintenance alternative B, it is assumed that the associated parts and specialists are also pooled. With alternative A, for each mission requiring parts or specialists the vehicle must go via the requesting unit. This requires a relatively long travel distance. With alternative B vehicles may travel directly to the job. This requires a travel distance shorter than the other pool alternative but longer than the current fleet travel distance.

Mission Demands. A current Combat Developments Command study "Family of Army Vehicles - 1985"[10] was consulted to obtain time frequency data on maintenance missions. The form of the data available was unit daily frequency totals for each type of vehicle mission.

Based on the discrete payload and mission function the order of

vehicle preference was determined by inspection of the available vehicles. Vehicles of closest higher payload capacities are used first. For parts delivery only, multiple vehicles of smaller payload were used with lower priorities.

Maintenance Vehicle Fleet Performance Results. Based on the current and pooled fleet alternatives, mission demands, and fleet operations, the performance of each alternative fleet was simulated. The results of these simulations are discussed in Chapter 5 and are given here only in summary form in Fig. S-6. This figure shows the performance of the current and pooled fleets in the form of cumulative mission completion time aggregated over the maintenance mission types of contact maintenance and parts delivery. The current fleet results are obtained by analysis of each unit maintenance activity and the combination of these individual results into the total maintenance vehicle response.

The mission completion times shown indicate that pooled fleet alternative B performs better overall than alternative A. With alternative B, a fleet size of between 50 and 60 percent of current fleet size provides performance equivalent to that of the current fleet. The cost implications of this pool and reduction in size of the maintenance vehicle fleet are fully discussed in Chapter 5. In summary the estimated cost savings from use of pooling alternative B are $9 million over a 12 year life cycle period. This amounts to one-third of the $27 million cost of the current fleet (vehicles and drivers).

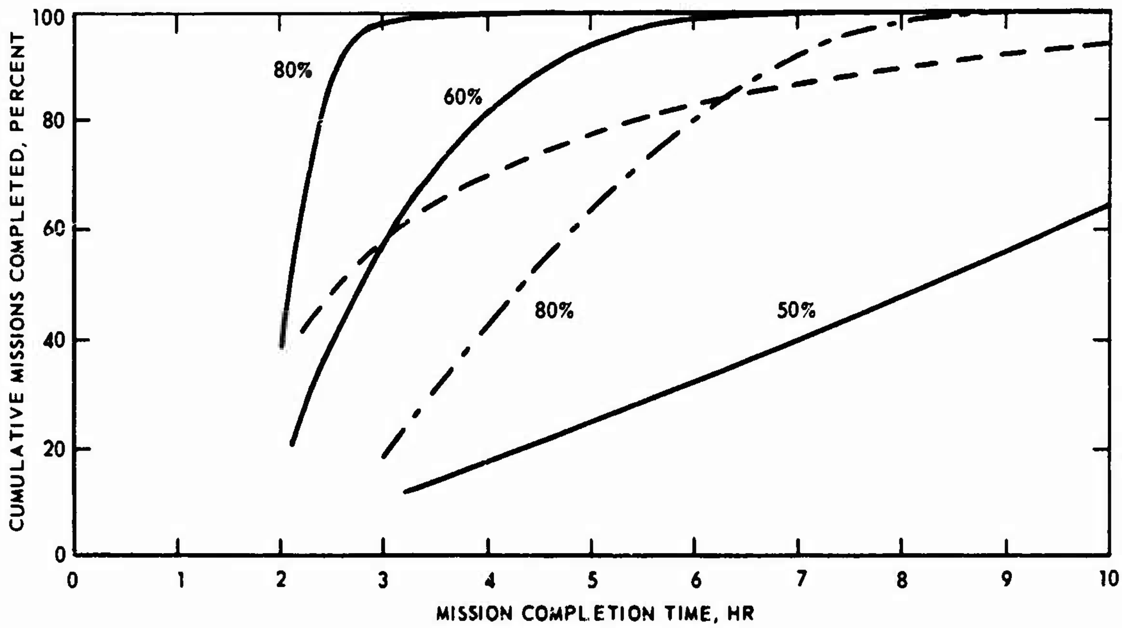


Fig. S-6—Mission Completion Times—Contact and Parts Pools

— — — Current fleet Pooled fleet: —·— Alternative A ——— Alternative B

Containerization

Introduction. A prime factor which inhibits the application of the concept of vehicle pooling is that many vehicles of the general cargo type carry loads which are permanently attached to the vehicle chassis. These loads, such as shop vans, laboratory sets, and fire control vans, are required on a continuous basis by the using unit and hence the vehicle chassis also remains stationary. The RAC study team was asked by the Army Study Advisory Group to examine the concept of containerizing these fixed loads and pooling the vehicle chassis at a centralized location. The objective is, of course, to examine the size of the pooled chassis fleet necessary to provide responsive movement of the containerized loads as a part of user unit moves and to evaluate possible vehicle and cost savings through this form of pooling.

A survey of tactical vehicles organic to the units within the 14th Support Group resulted in the selection of 475 vehicles carrying fixed loads that might be containerized and the chassis then pooled. The results of this survey are shown in Chapter 6 (Table 6-1), which includes the vehicle type and load, the unit to which the vehicle is currently assigned, and the number of assigned drivers for the vehicles selected. It should be emphasized that these vehicles represent only a fraction of those which may be carrying loads that could be containerized. However, since the objective of this portion of the study was to examine chassis pooling in concept only, it is felt that those vehicles selected are a clearly typical sample and are sufficient for purposes of analysis.

Simulation of Pooled Chassis Fleet Performance. The vehicle chassis extracted from the current fleet as described in the previous section were pooled in a centralized location and their performance as a pooled fleet simulated in a manner analogous to that used for unit moves in the cargo fleet pooling analysis. Using the same combat scenario, mission demands for the chassis fleet were generated by unit moves. When a unit move was necessary, the unit having containers to be moved requested the appropriate number of vehicles from the centralized pool. These vehicles were then dispatched as available, proceeded to the requesting unit, loaded the containers at the "old" unit location,

traveled to the new unit location and unloaded the containers. At this point the container move mission was considered complete and return travel time of the chassis vehicles is not included in mission completion time. Of course return travel time enters into overall fleet performance since the vehicles involved are unavailable to service other requested missions and mission delay time is thus generated.

The performance of the current fleet and pooled fleets of 60, 50, 40, and 30% of the 475 vehicle chassis available was simulated. Both the mission dispatch delay* and mission completion time results indicate that a pooled chassis fleet of 50% of the total number of chassis made available by pooling provides performance equivalent to that of the current fleet. At this level of performance over 92% of container move missions experience no delay in mission dispatch and all missions are dispatched within 8 hours of time of request. More importantly, the 50% pooled chassis fleet shows completion of 95% of requested missions within 8 hours, a figure very close to the simulated performance of the current fleet.

<u>Potential Fleet Cost Savings</u>. A cost comparison between the current fleet of 475 vehicles with fixed loads and the 50% pooled chassis fleet, which provides approximately equal simulated fleet performance, is given in Chapter 6.

The details of vehicle costing, however, become insignificant when compared with the issue of driver costs. The necessity of providing assigned drivers for the pooled chassis fleet versus the current policy of using additional duty drivers almost exclusively to drive the vehicles involved pushes the total cost of the pooled chassis fleet ($41 million) to a level higher than that of the current fleet, 25.9 million dollars.

In summary it would seem that the issue of containerizing many of the loads now fixed to vehicle chassis is dominated almost entirely by assigned driver costs and appears not feasible for this reason. It must be remembered in addition that the cost analysis performed does not include additional costs for load/unload devices for the containers.

*See Chapter 6, p 6-9.

These would have to be available, either on the chassis or at the using unit and would, of course, add to the cost of the container fleet.

POOLED FLEET ALTERNATIVES AND THE REVAL WHEELS SYSTEM

Total inclusion of the pooling analysis methods developed in this and the preceding RAC study into the REVAL WHEELS fleet planning model is not possible due to fundamental differences between the two models. REVAL WHEELS is vehicle task and force structure oriented, essentially matching vehicles and payloads and applying appropriate multipliers to arrive at total fleet size and cost for the entire army force structure. By contrast, the models developed in the tactical vehicle pooling studies are less oriented toward total force structure and more detailed in the consideration of the dynamics of mission performance within the vehicle task types selected for analysis. A fundamental difference between the two modeling systems is the use of mission frequency as well as type by the pooling methods developed. The REVAL system considers only the task to be performed by a vehicle - not its frequency of occurrence.

Even though the two fleet planning models cannot be totally integrated at the present, Chapter 7 presents a potential method to accomplish this integration in the future. In addition, examples of total fleet cost savings through pooling are presented in that chapter. These examples provide an interim method of assessing the impact of pooling on the tactical vehicle fleet.

TACTICAL VEHICLE POOLING

IN THE CORPS/ARMY SERVICE AREA

Chapter 1

INTRODUCTION

PURPOSE AND OBJECTIVES

The purpose of this study is to investigate the concept of tactical vehicle pooling within the organizational and operational context of a deployed field army. Concentration is on the risks and benefits of vehicle pooling within a typical corps/army service area including combat support and combat service support units and the tactical vehicles currently organic to these units.

The ultimate objective of the study is the production of a tested methodology which provides the Army fleet planner with a flexible, realistic tool for the evaluation of alternative concepts of tactical vehicle fleet organization and operations. This should be true in the sense that alternative fleet performance and costs may be quickly developed in a form suitable for decision making.

Specific objectives of the study are:

Identify and categorize tactical vehicle pooling opportunities within the units and associated vehicle assets of a deployed type field army.

Extend and refine methods of analysis of vehicle pooling previously developed and apply the refined methods to selected field army pooling problems.

Provide an automated system for the introduction of pooled vehicle fleet alternatives into the ACSFOR REVAL WHEELS fleet planning method.

BACKGROUND AND SCOPE

This study is a direct follow-on effort to RAC Study 010.128, "Analysis of Opportunities for the Reduction of Tactical Vehicles Through Pooling." This previous study analyzed the concept of vehicle pooling at the division level of organization. Tactical vehicle pooling

opportunities within a type infantry division were isolated; analytical methods (vehicle fleet performance simulations) were developed to investigate these opportunities. Included in the analysis were the vehicle assets, tasks performed, and divisional unit organizations and operations where pooling of vehicles appeared feasible and lucrative from the standpoint of reductions in fleet sizes and associated vehicle and personnel costs.

The methods developed were applied to specific example problems of vehicle pooling at the division level. Those areas investigated included the pooling of vehicles engaged in cargo transport, bulk liquid transport, maintenance vehicle operations, and ambulance evacuation operations. The analyses performed proved the methods developed to be flexible and realistic tools investigating the risks and benefits of vehicle pooling as compared to current fleet organization. In addition the specific results indicated that vehicle pooling could potentially result in significant reduction of vehicle requirements for cargo/bulk liquid transport and maintenance vehicle operations. These specific findings are to be viewed with caution from the standpoint of decision making, however, since much of the input data and many of the assumptions used have not been validated by field test exercises or military gaming.

The scope of the present study is broader and somewhat different in character from the previous work. All of the units, vehicle assets, and vehicle tasks of a type field army are considered with the exception of combat units, both divisional and non-divisional. Concentration is on combat support and combat service support units at the corps and army service area level. The present study thus includes a much broader spectrum of unit types, and the size of the geographic areas of deployment of these units is larger than that considered at the division level. The units and areas considered also reduced somewhat the variation in demand for vehicle services created by changes in unit combat posture since no combat units are included in the analysis.

STUDY APPROACH

The approach to tactical vehicle pooling analysis taken in this study is essentially the same as in the predecessor study with the

exception that the current effort is more closely tied to an actual combat scenario. This is in consonance with the fact that the basic study methodology had been tested and it was now proper to place more emphasis on the details of the pooling problems analyzed.

The first study tasks were the choice of a type field army organization and geographic deployment to use as a framework for isolation of tactical vehicle pooling opportunities. The vehicles of the type field army selected and the tasks performed by these vehicles as defined in REVAL WHEELS[1] were then systematically examined for those combinations of tasks and vehicle assets that appeared most promising for further analysis. These combinations were the vehicles engaged in cargo and bulk fuel transport and maintenance vehicle operations as well as an example problem dealing with containerized loads.

Prior to analysis of pooling in each of these cases it was necessary to select a suitable organizational and geographic area within the field army such that the numbers of vehicles and mission radii involved were manageable with the large sized computer available and such that current organization and operation of supply and maintenance doctrine were retained as much as possible. A corps support group and its area of operations was selected for these reasons. In addition, it was necessary to select a combat scenario to generate demands for tactical vehicle services within the selected organizational and geographic area. For this purpose the general scenario of the LOGEX 71 exercise[2] conducted at Ft. Lee, Virginia in May of 1971 was used.

With these tasks complete, each of the selected pooling problems was analyzed for comparative performance and approximate costs of the fleets as currently organized and the pooled fleet alternatives.

Finally, an automated routine was developed for the introduction of the results of pooling analysis into the REVAL WHEELS fleet planning methodology.

KEY ASSUMPTIONS

(1) The level of combat assumed throughout the study is mid to high intensity warfare with limited use of tactical nuclear weapons. The specific combat scenario was that used by the LOGEX 71 exercise.

(2) The unit strengths used in the study were those prescribed by the LOGEX scenario troop list for personnel and 100% TOE strength for tactical vehicles.

(3) Doctrine governing employment of current vehicle fleets is that contained in current Army field manuals.

(4) Vehicle attrition due to combat causes (enemy fire, mines, etc.) is not explicitly considered in the study. The effect of vehicle attrition is assumed to be equal for both pooled fleets and the fleet as currently organized. Vehicle losses from other sources (wearout, etc.) are explicitly considered in the analysis.

In regard to vehicle attrition it is interesting to note that in the period D+90 = D+96 of the LOGEX scenario the 2nd Corps service area lost 163 tactical vehicles, less than two percent of the total number of vehicles in units located in the corps service area.

(5) It is assumed throughout that vehicle travel in the army and corps service areas is along the main supply routes or other roads in the extensive road network of the scenario area. To the degree that on-road travel is impossible due to enemy interdiction, the performance of both pooled and non-pooled vehicle fleets would be degraded. A road network factor of 1.6 is used in the calculation of all mission radii used in the study to compensate for the difference between straight line map distances between units and the on-road travel distance.

VEHICLE FLEET PERFORMANCE SIMULATION

The purpose of fleet performance simulation is to deal in a quantitative manner with a problem too complex in detail to be reduced to a simple set of fleet performance equations. The objectives of the simulation developed in this and previous studies is to produce quantitative performance parameters for alternative vehicle fleets, each of which is subjected to a common spectrum of mission demands. These demands for vehicle services are derived as realistically as possible from the type of pooling problem under analysis and from the combat situation assumed in creating mission demand.

The basic fleet performance simulation used in this study is that developed and refined in the predecessor study, "Analysis of Opportunities for the Reduction of Tactical Vehicles Through Pooling." The simulation

is completely documented in Vol. III of the study report, RAC-TP-420. For reader convenience, however, a brief description of the simulation model is presented in App. A of this report and the essentials of the model including certain major refinements are presented here.

Figure 1-1 shows in greatly simplified form the basic logic of the fleet performance simulation. The core of the model is a set of routines which receive vehicle mission request inputs and which form and dispatch groups of vehicles to perform the requested missions. The model provides for several varieties of mission requests; both scheduled missions where the time of request is specified, and unscheduled in which request time is a random variable generated by a probability distribution.

As can be seen from Fig. 1-1 the model also provides for time accounting of vehicle group forming (the time from assignment of the first vehicle required for a mission to the time when the vehicle group is complete), loading, travel, unloading, and both scheduled and unscheduled maintenance time. A summarized list of the simulation input and output parameters is given in Table 1-1.

The refinements to this simulation model which were made during the course of the current study deal primarily with the manner in which certain mission related parameters are obtained and with the addition of output parameters which specify mission completion times in detail. The major capability added to the simulation is the ability to input unit positions (grid coordinates) and unit move frequencies. From these the simulation computes on a daily basis (over the entire number of days included in any given simulation run) the positions of units receiving services from the vehicle pool(s) and thus the mission radii for each requested mission. It was previously necessary to specify discretely the mission radius for each mission on each day of a simulation run. The enhanced capability represented by this change both reduces the volume of input data to be handled prior to fleet simulation and increases the dynamic nature of the simulation in that parameterizing unit move frequencies as a function of combat posture becomes very simple. In terms of added simulation output, the primary addition is the capability to output at the end of a simulation run the frequency distribution of mission completion times for any given mission type,

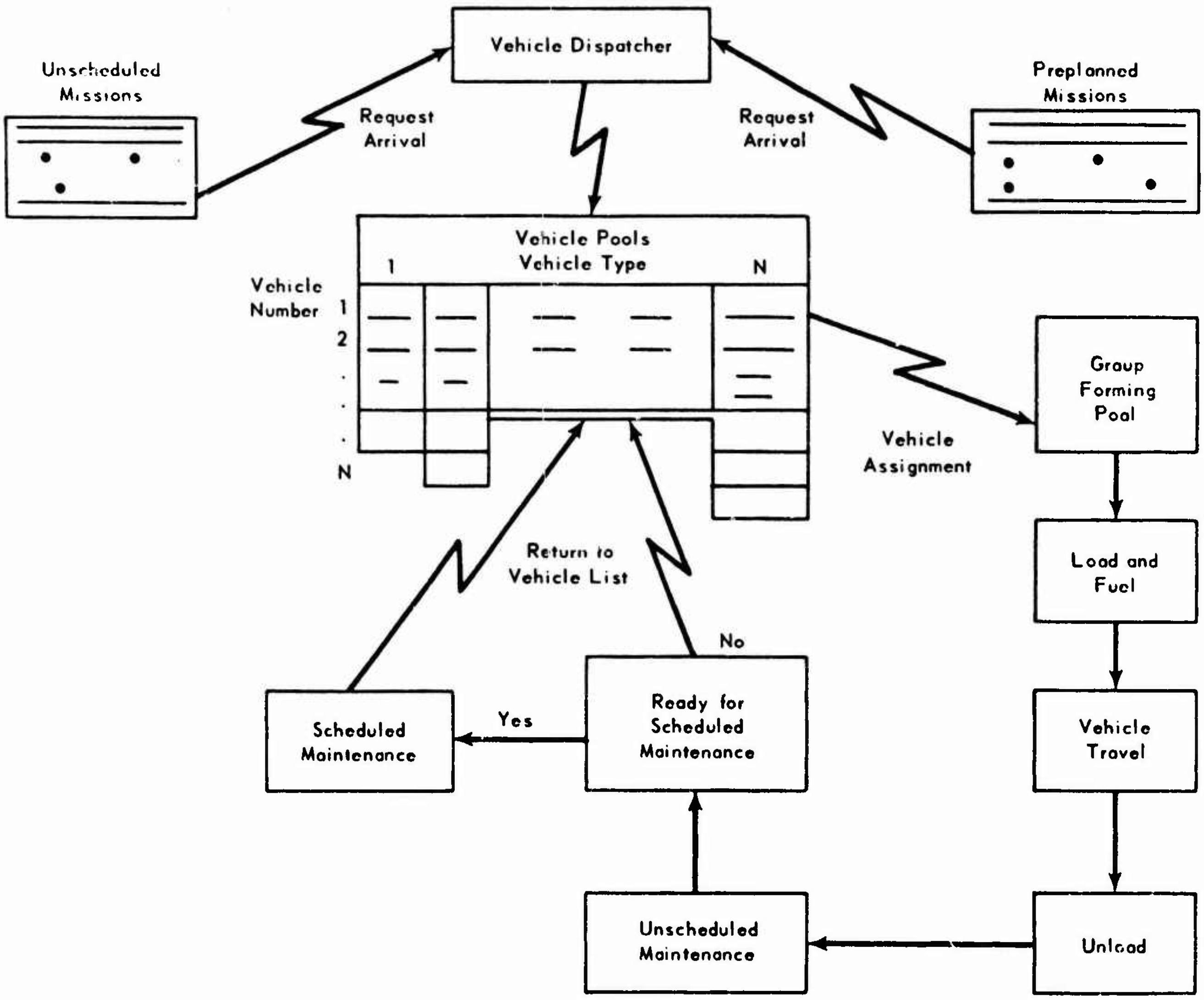


Fig. 1-1—Simulation Schematic

Table 1-1

FLEET PERFORMANCE SIMULATION PARAMETERS

Input Parameters

Mission Related
- Priority
- Payload
- Radius*
- Allowable Vehicle Pool
- Allowable Vehicle Type(s)

Vehicle Related
- Payload
- Operating Speed (On and Off-Road)
- Load/Unload Rate
- Maintenance History
- Scheduled Maintenance Interval and Duration
- Unscheduled Maintenance Interval and Duration Distributions

Operating Factors
- Simulation Duration (Days)
- Mission Request Start/Finish
- Mission Assignment Start/Finish
- Work Day Start/Finish
- Mission Discipline (Cancel or Day-to-Day Carryover)

Output Parameters

- Total Missions Requested
- Total Missions Completed
- Total Mission Delay Distribution
- Average Mission Delay Time and Standard Deviation
- Average Delay of Missions Delayed
- Total Mission Completion Time Distribution
- Vehicle Group Forming Waiting Time
- Total Vehicle Operating Time
- Total Vehicle Maintenance Time
- Total Vehicle Idle Time
- Total Vehicle Turnaround Time
- Number of Vehicles Utilized/Available

*Alternately, unit positions and move frequencies can be specified with the simulation computing mission radii on a daily basis.

e.g., ammunition resupply missions. The simulation thus becomes more oriented to output relevant to the needs of the units served by alternative fleet concepts. Not only are mission delay statistics available but the distribution of times from mission request to completion (for example, delivery of ammunition or the completion of a contact maintenance mission) are also available, providing a more complete comparison of the performance achieved by alternative fleet organizations.

The improved vehicle fleet simulation model just described is used in the analysis of each of the example pooling problems presented in following chapters. Simulation inputs and interpretations of results vary from problem to problem and are discussed in detail in the relevant chapters.

Chapter 2

SURVEY OF TACTICAL VEHICLE POOLING OPPORTUNITIES WITHIN A TYPE FIELD ARMY

INTRODUCTION

Isolation of potential vehicle pooling opportunities within a field army is dependent upon the organization of the type field army chosen for analysis, the tactical vehicle assets organic to the field army as found in its component TOE's, and the tasks performed by these vehicles under current fleet organization. The sections that follow deal with these subjects as part of the selection process by which vehicle pooling problems for detailed analysis were isolated. In addition a description is given of the scenario used to determine demand for vehicle services in the flect performance analyses that follow in succeeding chapters.

THE TYPE FIELD ARMY

A twelve division, three corps field army as used for instructional purposes by the Army Command and General Staff College at Ft. Leavenworth was chosen as the most representative type field army available for pooling analysis. This type field army is completely described in the CGS School Reference Book 101-10-1[3] and its overall organization is shown in Figs. 2-1, 2-2, and 2-3. This organization provided the list of TOE units from which the tactical vehicle assets of a field army could be extracted from the Army's REVAL WHEELS study and the tasks currently performed by the vehicles defined from data in the same study.

FIELD ARMY VEHICLE ASSETS AND TASKS

Using the list of TOE units with appropriate multipliers defined by the type field army, the total numbers of tactical vehicles were extracted from the REVAL WHEELS model task data tape. In addition to

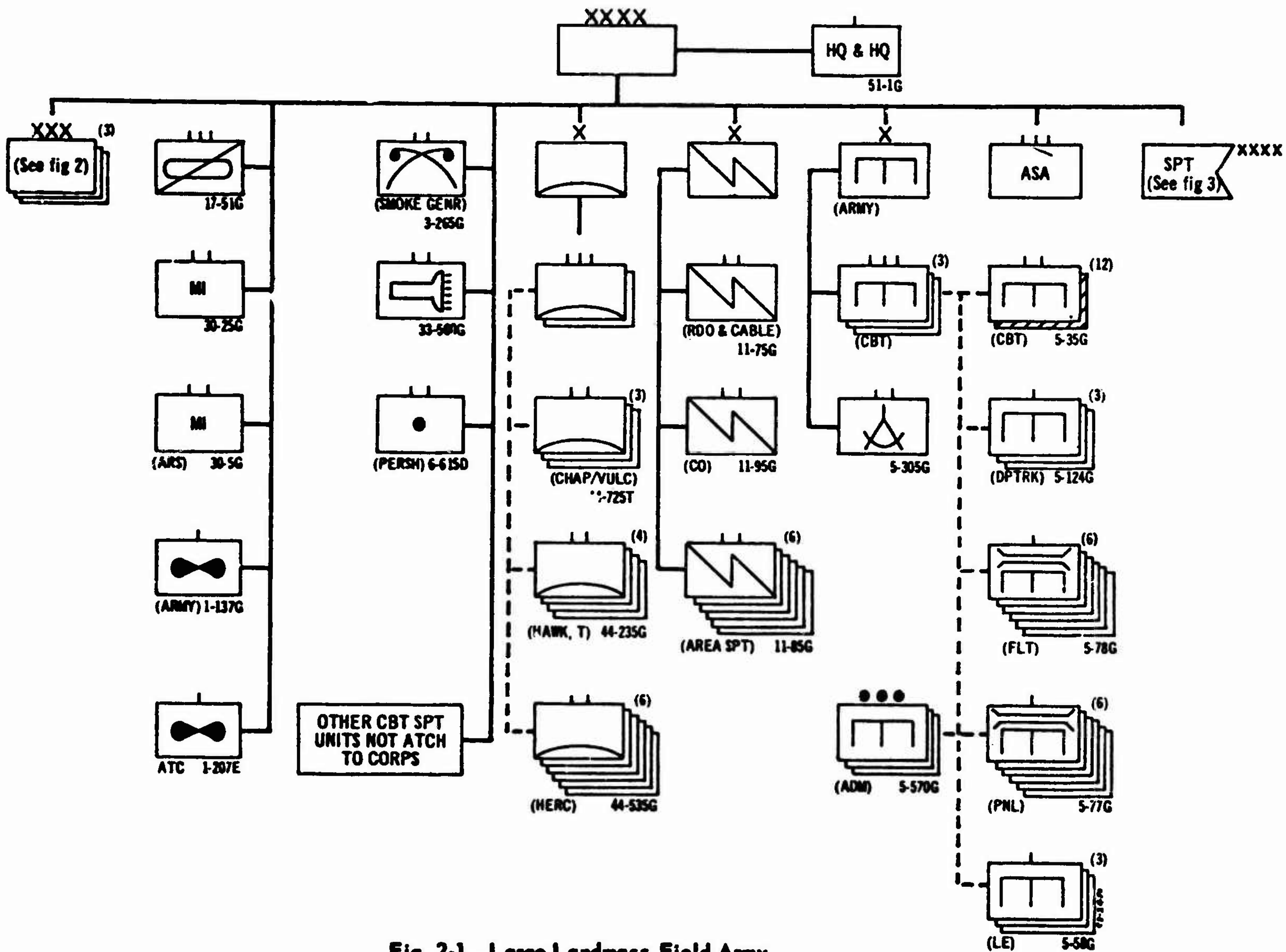


Fig. 2-1—Large Landmass Field Army

Group composition variable. Tailored from total subordinate units illustrated.

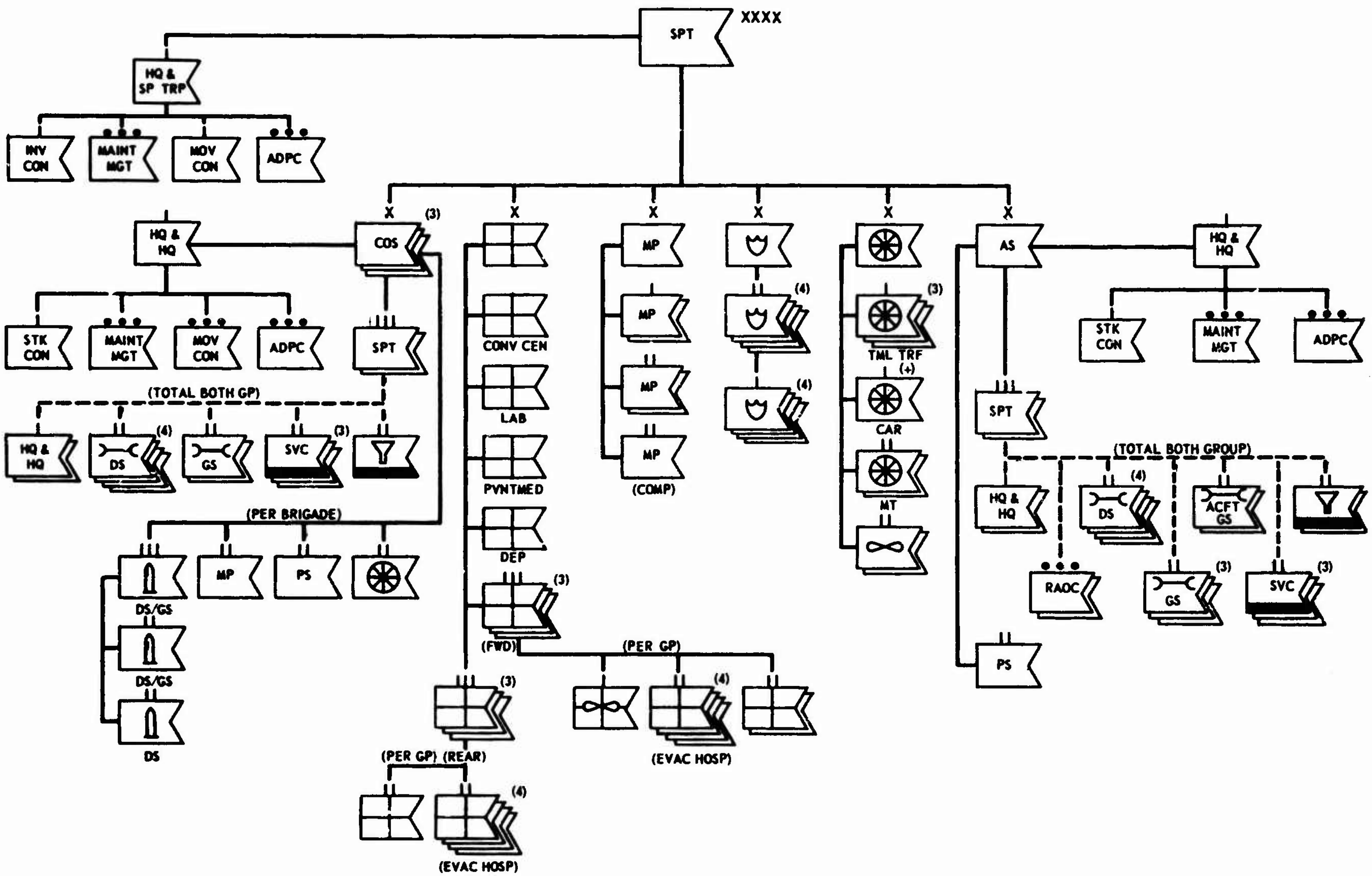


Fig. 2-2—Major Elements of Type FASCOM

Part of large landmass field army, 12-division force. Miscellaneous small units are not shown.
——— Support group composition variable. Tailored from subordinate units illustrated.

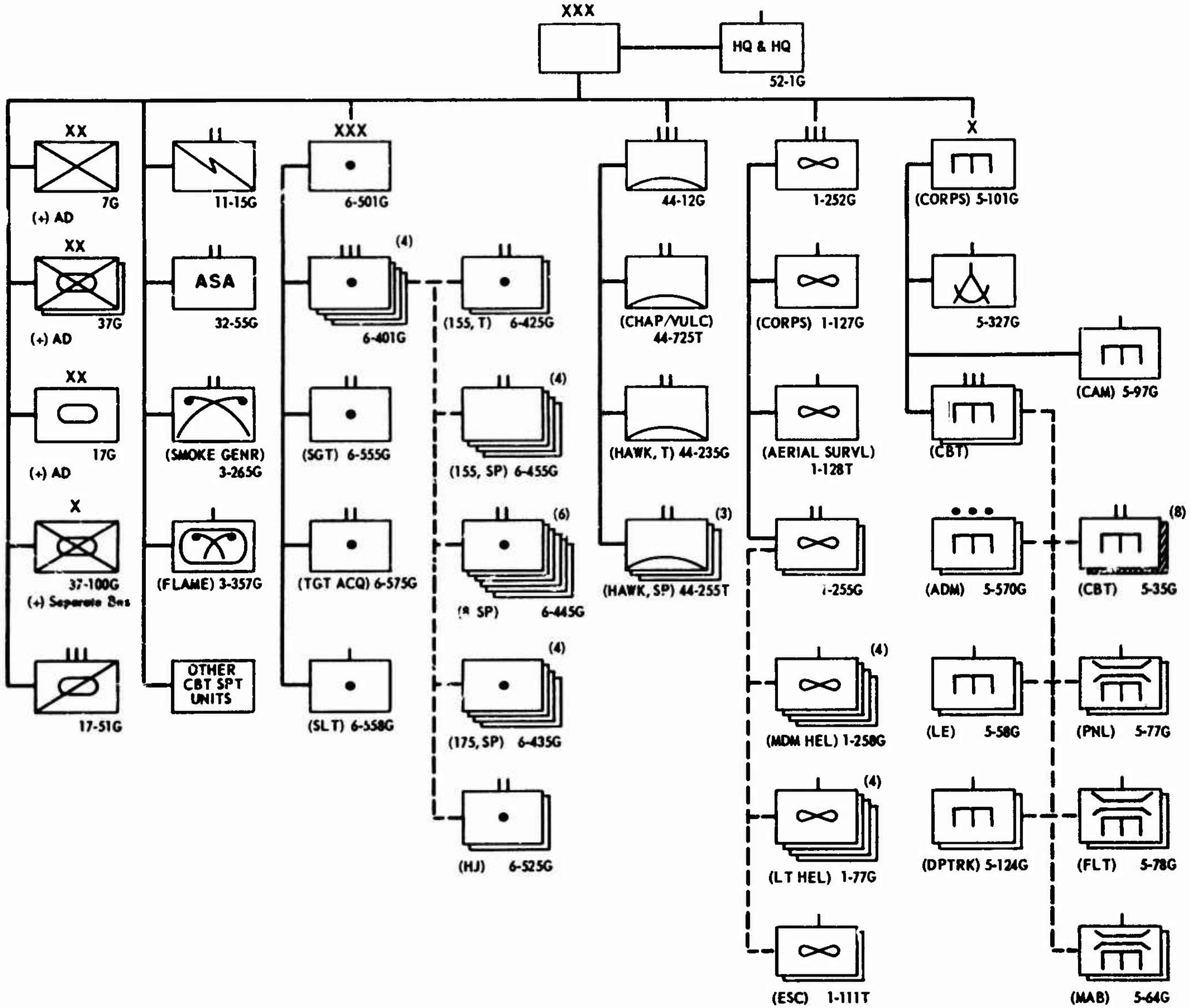


Fig. 2-3—Type Corps

Part of large landmass field army.

——— Composition variable. Tailored from total subordinate units illustrated.

numbers and types of tactical vehicles per unit, this extract specified the primary task performed by each vehicle as defined by the REVAL task type system. This vehicle task type system breaks down all tactical vehicle tasks into four basic task types, command and control, intelligence, logistics, and firepower, and 24 basic tasks within these types.

Table 2-1 shows the total tactical vehicle assets of the type field army broken down by these REVAL tasks and by major organizational subgroupings within the field army. Figure 2-4 summarizes in percentage form the allocation of vehicle assets by task.

SELECTION OF VEHICLE TASK-ASSET COMBINATIONS FOR POOLING ANALYSIS

As Table 2-1 and Fig. 2-4 show, the great majority of the tactical vehicle assets of a type field army are concentrated in the performance of a relatively few tasks. Over 85% of the vehicles are engaged in the commander and staff transport, commo/electronics facilities transport, cargo, bulk fuel, and engineer equipment transport, and in service support tasks. It is within these task-vehicle asset combinations that the maximum potential benefits from vehicle pooling would be expected and analysis is concentrated upon these tasks and vehicles.

Among those tasks not included in this group but which do have significant numbers of vehicles, e.g., fire control and mess facilities transport, the nature of the task itself requires the almost continuous presence of the vehicles involved at their units of assignment under current fleet organization. Vehicles carrying fire control equipment, for example, are required to be with their units continuously if the unit is to be effective in delivering fire support. This constraint obviously militates against the pooling of these vehicles at a central location to serve multiple users.

Similar constraints against vehicle pooling come into play with some of the task-vehicle asset combinations included in the group outlined above as having potential for pooling based only on numbers of vehicles involved. For example, the vehicles engaged in transport of communications/electronic equipment cannot be pooled unless the equipment carried is containerized and off-loaded at the using unit location since the continuous presence of the equipment is necessary for effective unit performance.

Table 2-1

FIELD ARMY TACTICAL VEHICLE ASSETS[1]

REVAL WHEELS task type	Field army base	FASCOM	Corps(3)	Total
Command and Control				
1.1 Commander & staff trans.	1477	2748	3648	7,870
1.2 Command & control of maneuver elements	0	0	0	0
1.3 Commo/electronics facility trans.	1184	252	1506	2,942
1.4 Liaison personnel trans.	41	48	129	218
1.5 Messenger trans.	75	32	21	128
1.6 Wire laying equipment trans.	352	32	999	1,383
1.7 Military police	0	972	0	972
Intelligence				
2.1 Recon personnel and equipment trans.	16	0	24	40
2.2 Surveillance personnel & equipment trans.	87	0	165	252
2.3 Security personnel equipment trans.	28	25	0	53
Logistics				
3.1 Cargo transport	1011	6914	3528	11,453
3.2 Bulk liquid transport	349	1814	756	2,919
3.3 Engineer equip. trans.	2115	168	3426	5,709
3.4 Retrieval operations	97	586	282	965
3.5 Service support	1042	5917	2475	9,434
3.6 Troop transport	9	0	0	9
3.7 Mess facilities trans.	227	513	636	1,376
3.8 Special (nuclear,missile)	60	78	144	282
Firepower				
4.1 Weapons platform trans.	0	0	36	36
4.2 Fire control	352	0	1848	2,200
4.3 Weapons transport	56	0	207	263
4.4 EW equipment trans.	156	0	291	447
4.5 CBR delivery syst. trans.	96	0	288	384
4.6 Prime movers	364	0	660	1,024
Totals	9194	20,096	21,069	50,359

1. Divisional combat units excluded.

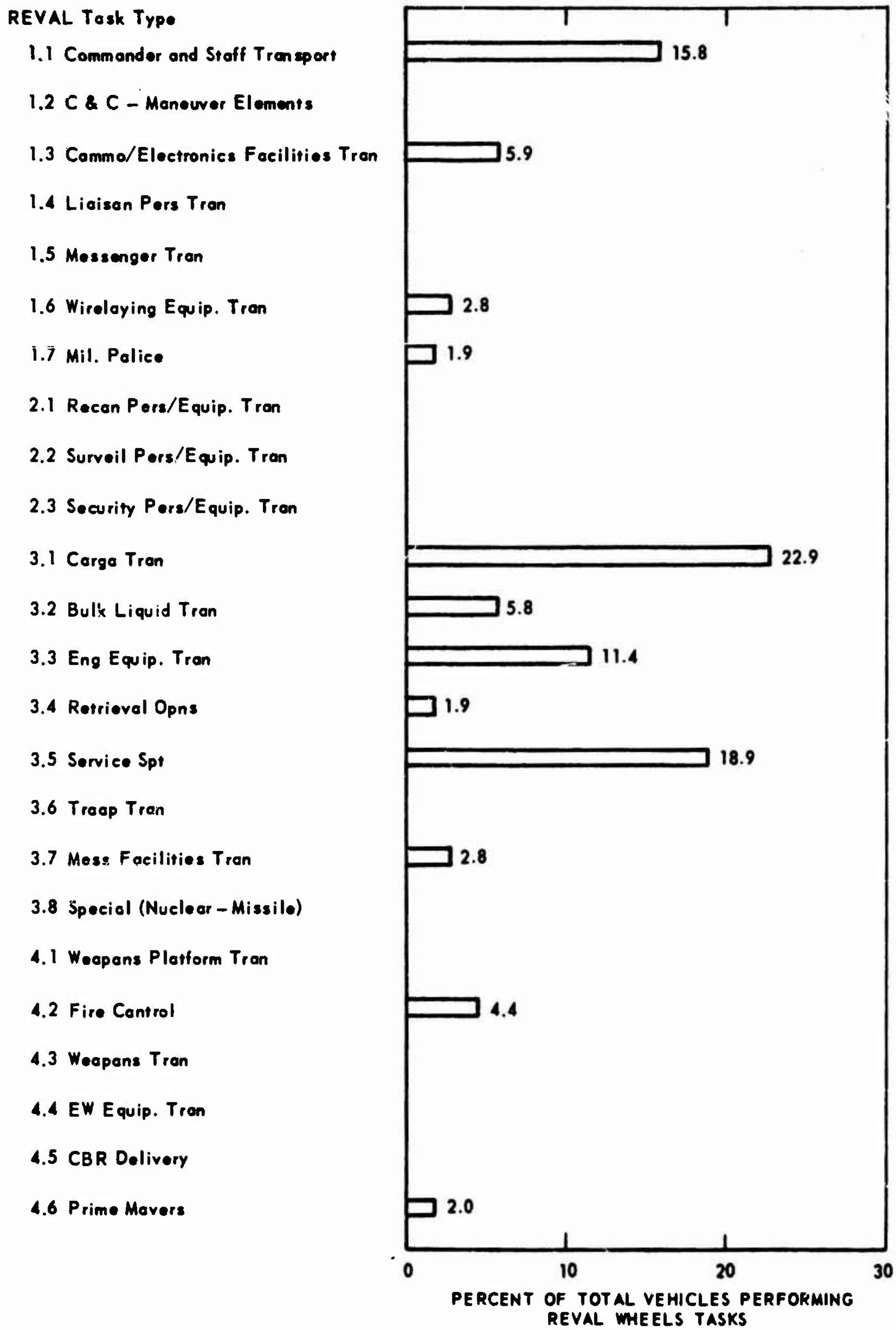


Fig. 2-4—Field Army Tactical Vehicles (No Divisional Forces)

Total vehicles = 50,359.

In like manner, the feasibility and potential of pooling commander and staff transport vehicles is doubtful due to the nature of the task and the way in which vehicles are used in its performance. Although these vehicles may not be in continuous use, the very short response times required when their use is necessary mitigates against removing them from the using unit and pooling them. In addition, reliable data on the time utilization of commander and staff transport vehicles are, at present, not available.

Unlike those task-vehicle assets combinations just discussed, vehicles performing cargo and bulk fuel transport and some of the vehicles engaged in the broadly defined REVAL WHEELS service support task offer potential for vehicle fleet cost savings through pooling. The vehicles transporting cargo and bulk fuel, and those performing maintenance operations are engaged in specific, well defined tasks that do not require the continuous presence of the vehicles at the physical location of the units served by them. It is in these tasks that vehicle pooling appears most feasible within the field army and which, (in addition to addressing containerization of certain vehicle loads in other tasks) are the subject of detailed analysis in this study.

ORGANIZATIONAL AND GEOGRAPHIC CONSTRAINTS

Having selected the tasks and associated tactical vehicles that prior to analysis, appeared to offer the greatest potential fleet cost savings through pooling, other factors involved in the feasibility of vehicle pooling must be taken into account. Obviously the pooling, for example, of all the cargo trucks within a type field army would result in a hugh pool of vehicles difficult to command and control, would generate mission radii to the units served of excessive length, and would cut across organizational and doctrinal lines already established for the smooth operation of combat service support.

A more logical approach was to consider the pooling of cargo, tanker, and maintenance vehicles within the areas of control of already established service support organizations such as a support group area within a corps or army support brigade. Analysis of vehicle pooling within a support group area not only establishes realistic mission radii for vehicle groups serving units from a central pool, but

provides a comprehensive analytical framework in that basically all combat service support (with the exception of line-haul operations) in the corps and army service areas of a deployed field army is provided by such support groups. All the functions of combat service support are included in the analysis while the dimensions of the problems handled are kept within the bounds of the storage capacity of standard large scale computers.

THE COMBAT SCENARIO

In addition to the selection of an appropriate organizational framework within the type field army, application of the pooling methodologies developed require the use of specific data including unit locations of a deployed field army and at least a general scenario of the combat situation in which the army is engaged. These data are required since not only the movement of cargo and bulk fuel and the operations of maintenance vehicles in both the fleet as currently organized and by pooled fleets are to be analyzed, but the impact of vehicle pooling upon unit mobility must be considered. Unit movement rates as well as resupply and maintenance demands require general scenario information in keeping with the overall assumptions of the study. The only scenario information of this type known to be available and which is concerned primarily with combat service support units is that used by the LOGEX studies concluded at Ft. Lee, Virginia.

The LOGEX 71 scenario employs a two corps, nine (+) division field army organized along the same lines as the type field army used by the CGS School at Ft. Leavenworth. The LOGEX Army (30th U.S.) is deployed in Western Europe, specifically in the Fulda Gap area of West Germany. Figure 2-5 shows the deployment at D+90 in the LOGEX scenario. The general scenario (partly illustrated by the tactical concept shown in Fig. 2-6) following D+90 is a sustained attack along the entire army front for a period of seven days, with the FEBA advancing during this period at an average rate of around ten kilometers per day. Having advanced to the line shown in Fig. 2-6 by D+96, emphasis then shifts to the southern or 2nd Corps area with the 23rd and 25th Armored Divisions attacking through the positions of the 55th and 56th Mechanized Divisions and driving toward the border of "aggressorland" for the next eight

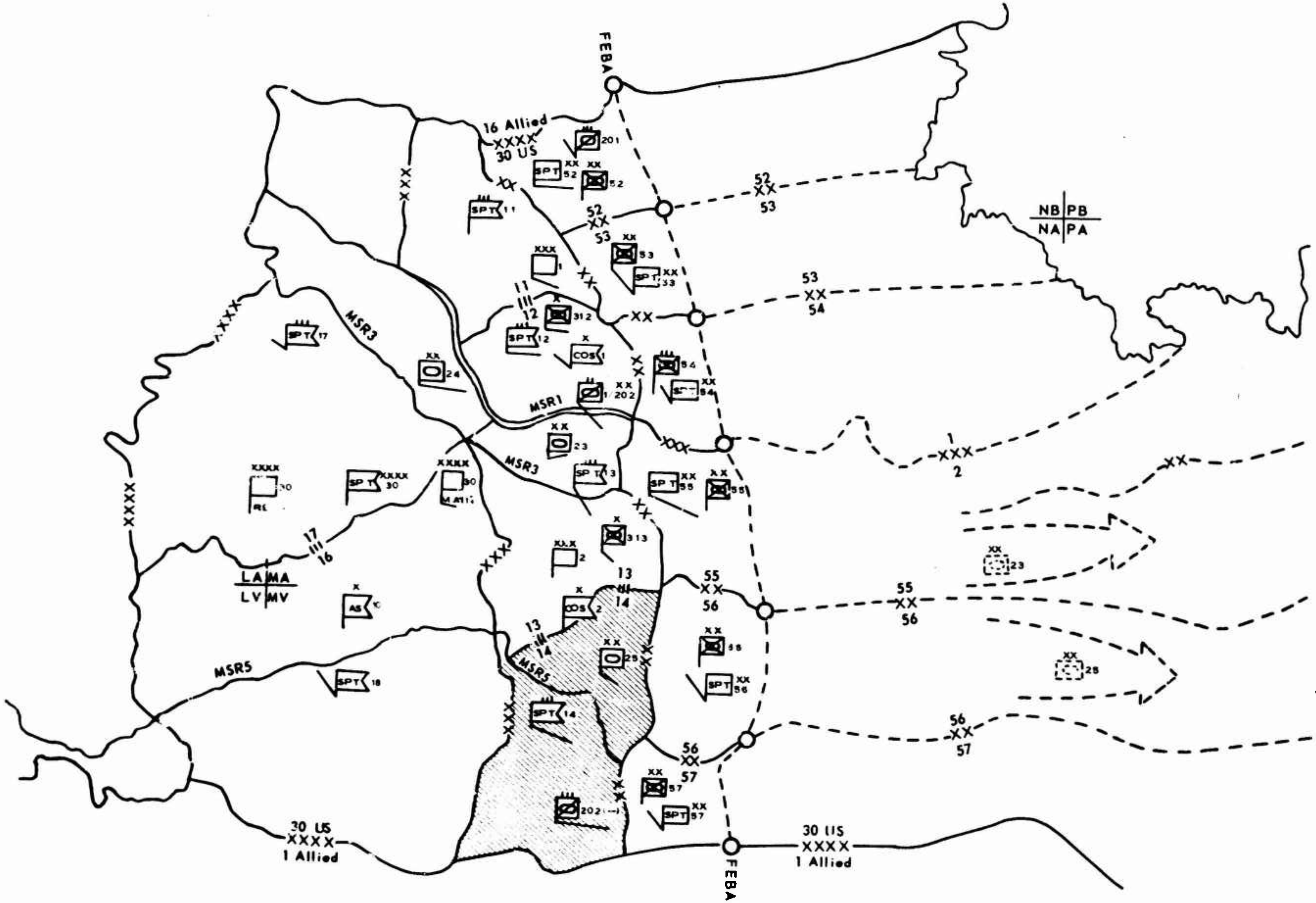


Fig. 2-5—Field Army Deployment—D+90

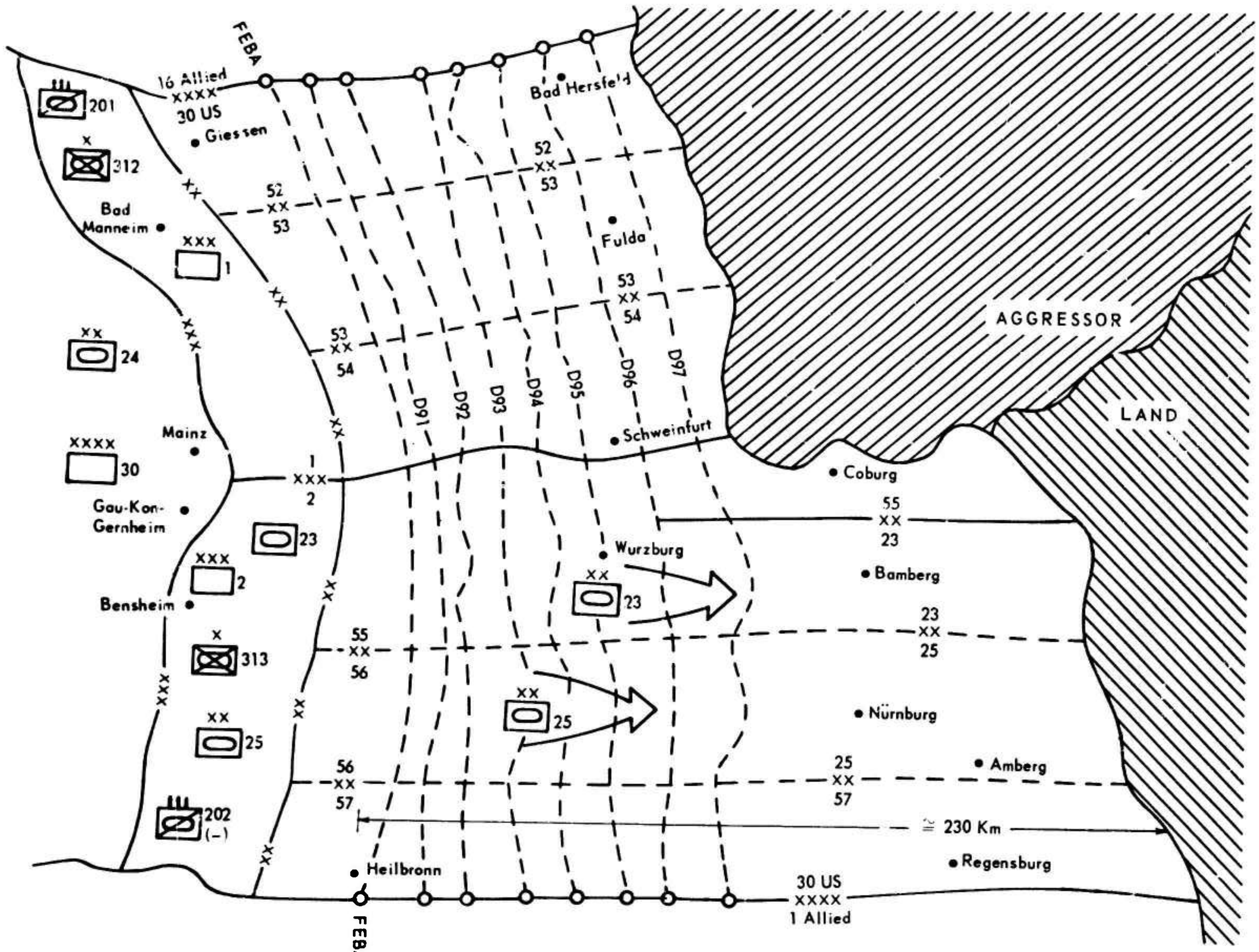


Fig. 2-6—Tactical Concept: LOGEX-71

days achieving the border at D+104 having advanced at a rate averaging about 20 km per day.

This scenario sets the combat postures of the field army as a whole and additionally leads to the choice of a corps support group area for pooling analysis. The 14th Corps Support Group of the 2nd Corps Support Brigade and the units operating within its area and in divisions forward were chosen. The area of operations of this support group is shown in cross-hatch on Fig. 2-5.

The 14th is a typical corps support group with all of the combat support and combat service support elements which should be included in the pooling analysis. In addition it is the most active support group in the army in this particular scenario, thus taxing the capabilities of the current fleet and any pooled fleet alternatives. Table 2-2 lists the units of the 14th Support Group along with other elements of 2nd Corps (primarily artillery, aviation, and ADA units) operating within its area or in the area of divisions directly ahead of the corps area. It is these units, their vehicle assets and operations within the LOGEX scenario that form the framework for the pooling analysis of succeeding chapters.

Table 2-2

UNITS LOCATED IN 14TH SUPPORT GROUP AREA*

Aviation Units

1 - HHC avn gp
1 - Avn air wpns co
1 - Avn air survl co
2 - Avn bn (-)

Chemical Units

1 - Chemical bn (-) (Smoke genr)

Engineer Units

1 - HHC cbt eng gp
1 - Eng topo co
6 - Cbt eng bn
2 - Eng aslt brg co
2 - Eng pnl brg co
1 - Eng flt brg co
1 - Eng dptrk co
2 - Eng lt eng co

Artillery Units

1 - HHB corps arty
1 - FA tgt acq bn
1 - FA bn sgt
3 - HHB FA gp
2 - FA bn 155 towed
4 - FA bn 155 sp
5 - FA bn 8 in. sp
4 - FA bn 175 sp
2 - FA bn HJ

Medical Units

1 - HHD med gp
1 - Med bn
2 - Evac hosp
1 - Med co air amb
3 - Mob ar surg hosp

Ordnance Units

1 - Ord ammo bn (+)

Signal Units

1 - Signal bn cbt area

MP Units

1 - MP bn (-)

Supply and Service Units

1 - HHC spt bde
1 - HHC gen spt gp
2 - S&S bn (-)
1 - P&A bn (-)
1 - Petrl sup bn

Maintenance Units

2 - Maint bn ds (-)
1 - Maint bn gs

Air Defense Arty Units

1 - HHB ADA gp
3 - ADA bn hawk

Transportation Units

1 - Tran mtr tran bn (+)

*Including corps units positioned forward in division areas.

Chapter 3

CARGO VEHICLE POOLING

INTRODUCTION

This chapter addresses the problem of pooling the vehicles designated by the REVAL WHEELS system as performing cargo transport (task 3.1) for the units located in the 14th support group area of operations. The primary objective of analysis is the comparison of pooled and current fleet performance of cargo transport missions under varying levels of mission demand and for several levels of fleet size reduction for the pooled fleets.

The organization of the analysis reported in succeeding sections of this chapter is as follows. Cargo missions to be performed by both the fleet as currently organized and by the pooled fleet are defined and the operations of both fleet organizations in performing these missions are described. The vehicle assets of the current fleet and the pooled fleet alternatives are then outlined and the mission demand for vehicle services as a function of combat posture is detailed. The inputs to the vehicle fleet performance simulation and the array of simulation runs made are then discussed. The final sections of the chapter deal with simulation results, comparing pooled vs current cargo fleet performance and costs.

CARGO FLEET MISSIONS

There are basically two types of missions which must be performed by the fleet of cargo vehicles, whether the fleet vehicles are pooled or organic to using units. These missions are first, the resupply of units with the necessary items of all classes of supply currently handled by the cargo fleet, and second, the movement of the portion of

unit equipment and reserve supplies normally carried by the cargo vehicles (under current fleet organization) in the event of unit moves.

In addition to the two basic cargo vehicle fleet missions, other missions exist or can be envisioned. Secondary missions such as troop transport, haulage of unit mail, etc. have been discussed in the course of the previous study on tactical vehicle pooling. These secondary missions are not included in the present analysis for two reasons. First, under the REVAL WHEELS task definitions, other vehicles in the units are designated to handle such missions or the missions are handled by specialized units, e.g., haulage of mail by APO units. Second, virtually no data exist on the frequency of occurrence or the quantity of materiel to be moved by the cargo fleet in such secondary missions. For this reason quantitative comparisons between alternative fleet organizations performing these secondary missions in addition to the primary missions would be infeasible at the present time. It is simply assumed that the additional burden on fleet capacity posed by secondary missions would affect current and pooled fleet organizations equally, and since these secondary missions would comprise a relatively small portion of total mission demand, comparison of fleet performance using only primary mission demand is valid.

CURRENT CARGO FLEET ORGANIZATION AND OPERATIONS

The fleet or cargo vehicles organic to units of a corps support group such as the 14th has two primary modes of operation under current fleet organization. These operations are dependent upon the unit and its service support role. The cargo vehicles of the line haul transportation units such as the transportation light/medium truck companies haul cargo into the corps service area (for delivery to units operating supply points) and haul cargo through the corps area to both the division support commands and, in some cases, directly to the units of the divisions forward of the corps area.

The remaining cargo vehicles currently organic to units in the 14th Corps Support Group area move resupply from supply points to their units, move unit equipment when the unit displaces, and warehouse on wheels unit supply reserves. A schematic of current fleet operations is shown in Fig. 3-1. Organization of the fleet is user unit organic

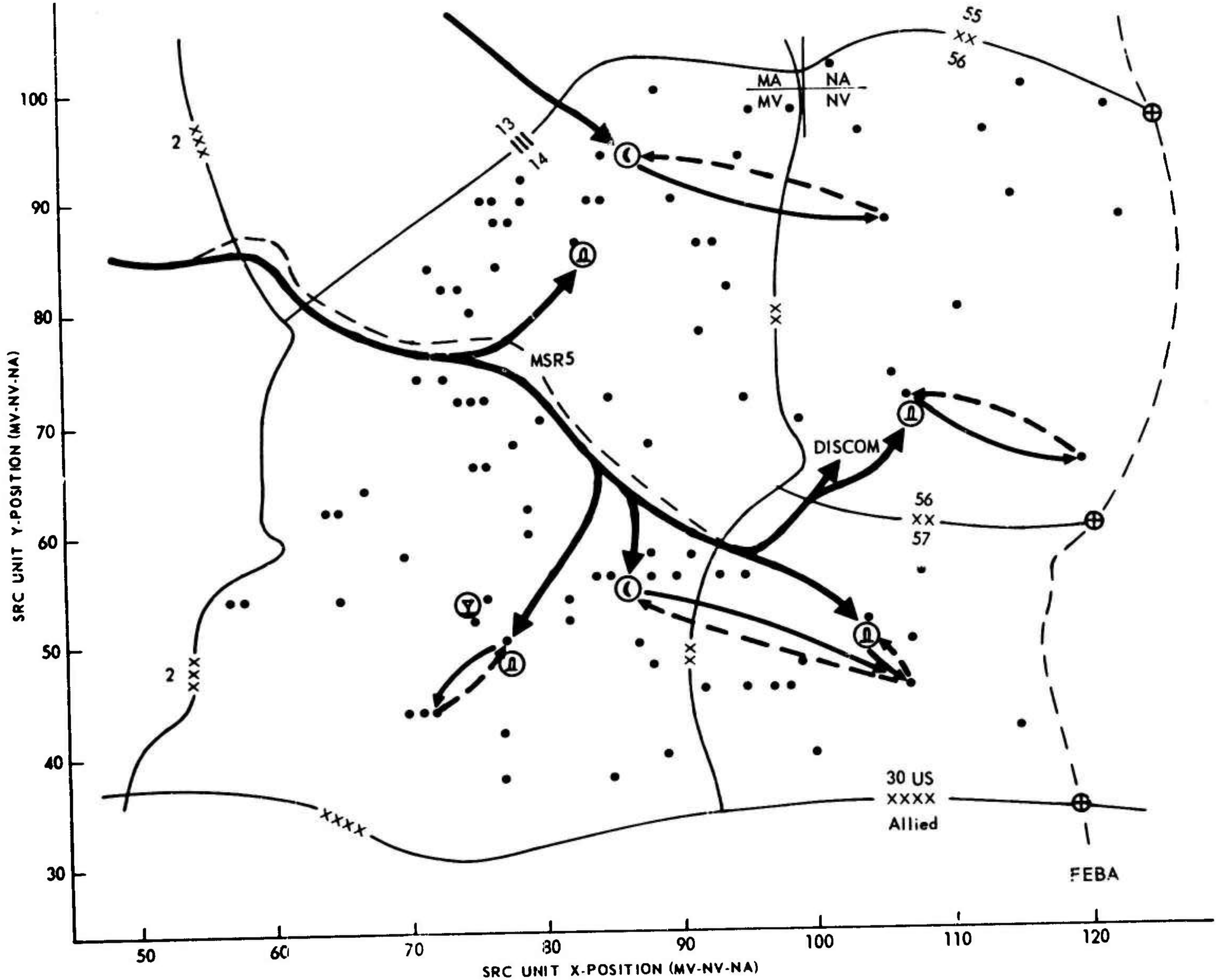


Fig. 3.1—Current Fleet Operations—14th Support Group Area

Line haul operations — Empty unit vehicles — Full unit vehicles

(except for line haul transport units) and vehicles are widely dispersed around the corps service area in relatively small groups which serve as cargo carriers only for their specific unit.

POOLED CARGO FLEET ORGANIZATION AND OPERATIONS

Cargo fleet pooling in the corps support group area departs radically from current fleet organization and operations. With certain major exceptions, the cargo vehicles of all units operating within the support group area are pooled at a location near the center of the area and just to the rear of the division boundaries. Vehicles then serve outward from the pool and under centralized command and control perform the missions of unit resupply and assistance in unit moves. The operational schematic shown in Fig. 3-2 gives a functional picture of pooled fleet operations as compared with the current fleet (Fig. 3-1).

Excepted from this pooling scheme are the vehicles organic to line haul transportation units and certain of the vehicles organic to artillery battalions. The functions performed by cargo trucks in the transport units obviously make them unavailable for pooling since it is these vehicles which bring material to the supply points from which pooled vehicles engaged in the area service function can pick it up and deliver it to using units. The track-laying M548 ammunition carriers of the artillery battalions are not pooled since they are primarily utilized in transfer of ammunition for the firing batteries from the battalion trains areas to the batteries, and in warehousing much of the battalion's basic load of ammunition.* In addition to these exceptions, none of the semitrailers and tractors of the supply and maintenance units are pooled. The functions of these vehicles are either line haul of supplies or use as warehousing vehicles for supply reserves including repair parts.

As is apparent from the cargo vehicle pooling scheme outlined, the intent of analysis is to compare the performance, risks, and costs of pooled fleets versus the current fleet in providing resupply and unit

On the average, 45.5 percent of the basic load of the artillery battalions included in the analysis is warehoused on the 6 ton ammunition carriers.

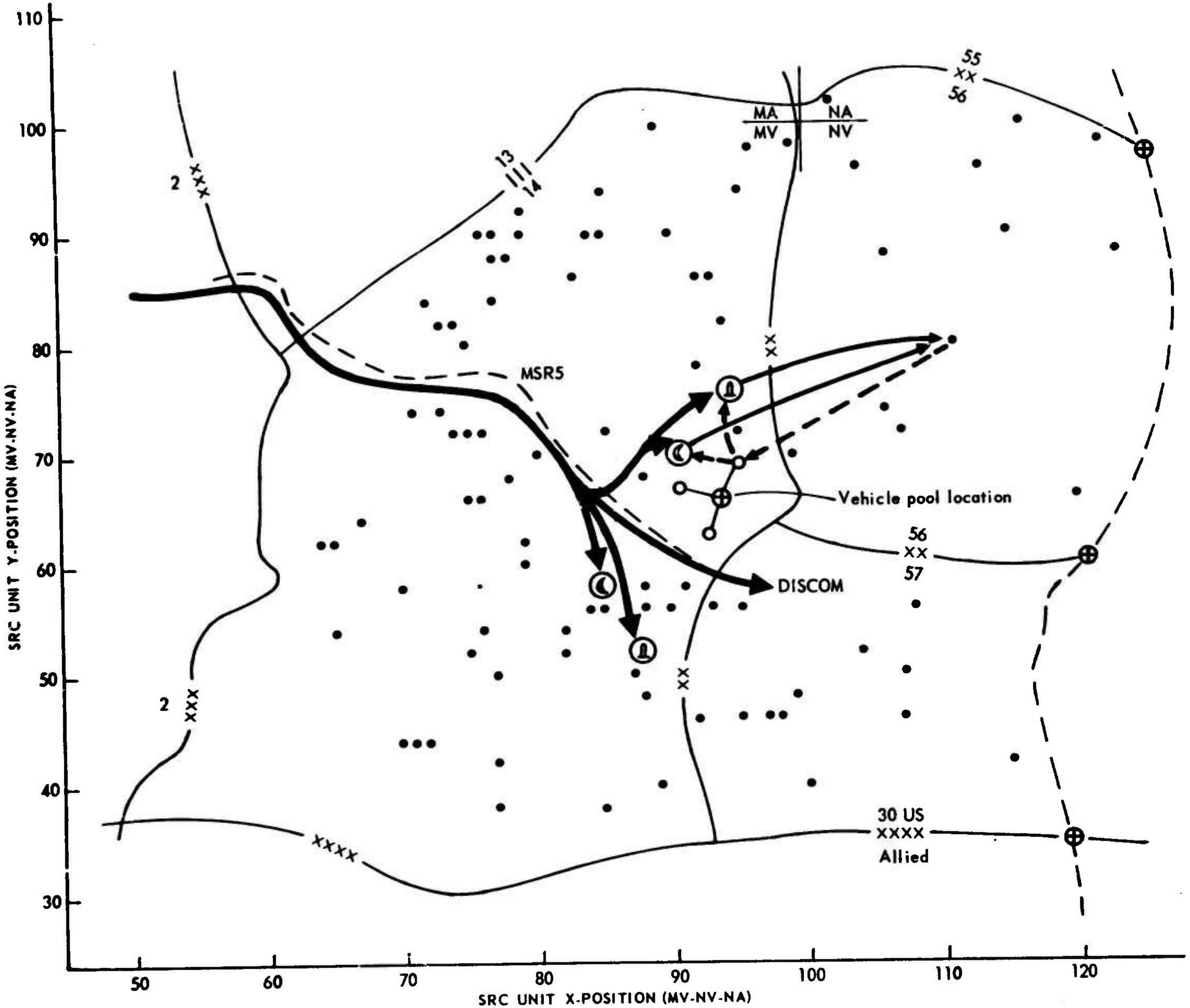


Fig. 3-2—Pooled Fleet Operations—14th Support Group Area

Line haul operations — Empty pool vehicles — Loaded pool vehicles

move assistance to the units of the 14th Support Group and the corps artillery and engineer units operating in divisions forward. Provision of line haul capacity and warehousing on wheels of reserve supply is deliberately made equal for both the current and the alternative pooled fleets.

TACTICAL VEHICLE ASSETS

Vehicle Numbers

Table 3-1 shows the total cargo vehicle assets currently organic to the corps and army units located in the 14th Support Group area. The left hand column of figures shows the vehicle assets with which the current fleet resupplies and assists in moving the units in the area, and in addition includes the vehicles organic to line haul organizations such as the transportation light-medium truck companies. From this total of 1763 vehicles are extracted those vehicles shown in the right hand column which are used in both the current and pooled organization vehicle fleet performance simulations. Not included are the 6-ton ammunition carriers of the corps artillery battalions, the vehicles organic to line haul organizations, and certain semitrailers belonging to supply or maintenance units. The reasons for these exclusions were outlined in the previous section.

The remaining 1119 vehicles shown in the right hand column of Table 3-1 comprise the current fleet engaged in serving area units (from the units themselves) and are also the total number of vehicles in the pooled fleet before any fleet size reductions are made. It is these two fleets, the current organization at full strength and the pooled fleet at varying levels of reduced fleet size which are to be compared in the performance simulations which follow.

Vehicle Characteristics

Table 3-2 presents pertinent characteristics of the vehicle types contained in the fleets described in the preceding sections. These characteristics are used as input to the performance simulations and include their payload, costs (excluding drivers) and both scheduled and unscheduled maintenance factors. Average on-road payloads from FM 101-10-1[4] are used since the road network in the scenario area is

Table 3-1

TOTAL CARGO VEHICLE ASSETS

14th Corps Support Group Area

Vehicle and trailer type	No. in current fleet	No. in pooled fleet (100%)
3/4 ton cargo (M37)	93	73
3/4 ton cargo (M37) + 3/4 ton cargo tlr (M101)	335	335
$2\frac{1}{2}$ ton cargo (M35)	85	85
$2\frac{1}{2}$ ton cargo (M35) + $1\frac{1}{2}$ ton cargo tlr (M105)	668	423
5 ton cargo (M54)	29	29
5 ton cargo (M54) + $1\frac{1}{2}$ ton cargo tlr (M105)	174	174
6 ton ammunition carrier (M548)	168	0
5-10 ton tractor (M52,M125) 6-12 ton semi-trailer combinations	127	0
Separate 6-12 ton semi-trailers	84	0
Total vehicle/trailer combinations and separate trailers[1]	1763	1119

1. Differences between current and pooled fleet numbers, both in total and by vehicle type are due to exclusion from the pooled fleet of vehicles from line haul transportation units, and exclusion of all 6 ton ammunition carriers and tractor-semi-trailer combinations.

Table 3-2

CARGO VEHICLE CHARACTERISTICS

Model designator	Payload class	Payload-tons (on-road ave.)	Cost (12 yr life-cycle)[1]	Maintenance factors: Scheduled DH/OH[2]	Maintenance factors: Unscheduled DH/OH[2]
M37	3/4 ton cargo	1.0	$23,835	.057	.063
M37/M101	3/4 ton cargo w/tlr	2.1	27,174	.067	.074
M35	2½ ton cargo	4.0	35,310	.067	.080
M35/M105	2½ ton cargo w/tlr	6.0	38,901	.078	.091
M54	5 ton cargo	6.0	52,946	.074	.094
M54/M105	5 ton cargo w/tlr	8.0	56,537	.085	.105

1. Excluding driver costs, obtained from REVAL WHEELS study group.

2. Down hours/operating hour: derivation of this data is contained in Ref. 7, App. E.

extensive and most vehicle travel in the corps service area is on-road. Costs are 12-year life-cycle costs in conformance with standard vehicle costing procedures. Vehicle operating speed is not shown in Table 3-2 since it is assumed common across all vehicle types; 40 kph as shown in FM 101-10-1.

DEMAND FOR VEHICLE SERVICES

The consumption of supplies and the movement of units in conformance with the LOGEX scenario are the basic generating factors that create demand for cargo vehicle services in the corps support group area. Consumption of supplies creates the demand for resupply missions with mission payloads dictated by the using unit's needs in a specific combat posture or situation. Unit movement creates demand for cargo vehicles to assist in moving unit supplies and equipment whether those vehicles are unit organic or pooled. Unit move frequencies are generated by the combat situation as defined in the LOGEX scenario.

Cargo Resupply Mission Demand

Unit needs for certain classes of supply were determined from two sources. For those units considered by the LOGALOC II Study,[5] tonnages per day in the two combat postures of the scenario (attack and pursuit or exploitation) were available. These tonnages are shown in Table 3-3. For the remaining units, daily resupply tonnages based on lb/man/day were calculated from the factors contained in the Armed Forces Planning Guide Europe[6] and shown in Table 3-4. The resulting resupply tonnages for each of the 96 units not covered in LOGALOC II data are given in Table C-1, App. C. It is these tonnages which the cargo vehicle fleet, current or pooled, must deliver to the using units on a daily basis in the fleet performance simulation.

Unit Move Mission Demands

Mission demand for pooled cargo fleet vehicles is created by unit moves. Pooled vehicles, having been removed from the unit's total mobility assets, should provide the service of moving the same tonnage of unit equipment and supplies in the event of unit moves as was carried by the cargo vehicles removed from the unit by pooling. The same mission demand is, of course, required of the cargo trucks of the current fleet

Table 3-3

CARGO RESUPPLY TONNAGES

14th Support Group Area Units
Included in LOGALOC II Study

Consuming unit	Ammunition resupply-ton Attack posture	Ammunition resupply-ton Pursuit posture	Other cargo resupply-ton Attack posture	Other cargo resupply-ton Pursuit posture
1 - 77G Airmobile co light	0.32	0.01	2.73	2.71
1 - 111T Avn air weapons co	13.50	8.10	2.66	2.66
1 - 258G Avn med hel co	0.07	0.06	4.80	4.79
5 - 35G Eng combat bn	2.74	0.66	4.99	5.44
5 - 58G Eng lt equip co	0.36	0.08	1.49	1.97
6 - 415E 8 in. how bn SP	97.47	16.36	3.19	3.11
6 - 425G 155 how bn towed	103.70	18.39	3.03	3.01
6 - 435G 175 bn SP	105.70	16.89	3.05	2.96
6 - 445G 155 how bn SP	102.50	18.10	2.87	2.81
8 - 137G Med air amb co	0.07	0.01	2.85	2.79
44 - 235G Hawk bn	0.64[1]	0.64[1]	4.61	4.56

1. Not including resupply of missiles.

Table 3-4

RESUPPLY FACTORS

14th Support Group Area Units[1]

Class of supply	lb/man/day
I	6.40
II	7.04
III (packaged)	4.50
III (bulk)	51.60
IV	4.11
V	0.60
VI	4.50
VII	2.51[2]
VIII	0.25
IX	4.80[3]
X	5.90[2]
Total lb/man/day (not including bulk petrl.)	28.20

1. Source - Army Force Planning Guide - Europe (User Codes 08 & 10).
2. Not handled by pooled fleet in the area service mission.
3. Only 0.80 lb/man/day handled by pooled fleet.

organization. The load placed upon both types of fleets by unit moves depends upon the payloads to be carried by the cargo vehicles and the frequency of unit moves.

Unit Move Payloads. The payloads to be carried by cargo vehicles during unit moves were initially taken to be those specified as the task load usually carried by the vehicles in the REVAL WHEELS study. The total of these loads is a unit move mission payload for the pooled fleet.

For example in forming the pooled fleet two cargo vehicles, both $2\frac{1}{2}$ ton trucks with trailers were removed from the 2053 Light Maintenance DS Co. (TOE 29-207), one of the two such units in the 14th Support Group Area. Extracts from the REVAL WHEELS task-data tape specify the load usually carried by each of these truck-trailer combinations as 2900 lb; a total of 5800 lb or 2.9 tons. This total of 2.9 tons is the payload used for a unit move mission in simulation of both pooled and current fleet performance. In the same way, unit move payloads were derived for each of the 127 units included in the analysis. A complete listing of unit move payloads is given in Table C-1, App. C.

As can be noted from a comparison of unit move payloads derived from REVAL WHEELS with the tonnage capacity of the vehicles pooled from each unit, the total tonnage capacity of the vehicles is seldom utilized when the REVAL payloads are carried. To check the sensitivity of analysis results to this apparent under-utilization of vehicle capacity, an alternate set of unit move payloads was computed using the off-road rated capacity of the vehicles involved for each case. In the example above, for instance, the unit move payload for the light maintenance company became 8.0 tons (2-$2\frac{1}{2}$ ton trucks + $1\frac{1}{2}$ ton trailers). These alternative unit move payloads were then used in the fleet performance simulation model.* It could be argued that on-road rather than off-road rated payloads should be used to compute these unit move payloads. A cross-check with REVAL data showed, however, that for many of the loads carried, the vehicles were volume rather than weight limited in capacity; thus the lower off-road tonnages were used.

*See Table C-2, App. C for complete listing.

Frequency of Unit Moves

The frequency with which unit moves occur, and thus demand for vehicle services to assist in unit moves is determined by the combat scenario in a manner quite distinct from demand for cargo resupply. In the resupply case, it was assumed that resupply of units occurs daily with the amount of resupply varying with combat posture. With unit moves almost the opposite is the case. Tonnages of unit equipment and supply remain more constant but the frequency with which this tonnage must be displaced in a unit move is more directly a function of combat posture.

An extensive literature search produced little data on the frequency of unit moves in the corps or Army service area, although a good deal of data on unit move frequencies is available on combat units at the battalion level and on selected combat support units such as artillery elements. Because of this lack of data it was necessary to derive unit move frequencies directly from indicators of the rate of flux in the combat situation, primarily the movement rate of the FEBA (Forward Edge of the Battle Area). A sufficient amount of data is available on FEBA movement rates for various force ratios and combat situations to permit this derivation and, of course, the LOGEX scenario used throughout the study defines FEBA movement rates in that specific combat situation as described in Chapter 2.[8,9]

The results of analysis of unit move frequencies as a function of FEBA movement are shown in Table 3-5 and the drivation process for these frequencies is given in detail in App. B. Primary consideration was given to two factors influencing unit moves. These were, first, that corps artillery units must displace sufficiently often to provide continuous fire support for divisional units on the line. Secondly, other combat support and combat service support units must move often enough that the distance to the units supported remains sufficiently short that travel to and from these units can be accomplished in one ten hour shift of the 20-hour combat day. The combat scenario used by the LOGEX study results in FEBA advancement rates of 10 kilometers per day (kpd) from D+90 to D+96 and 20 kpd from D+97 through D+104. These FEBA movement rates as seen in Table 3-5 result in artillery unit moves

once every two days (0.5) in the period D+90 + D+96 and once a day (1.0) thereafter. Corresponding movement frequencies of once every eight days (0.125) and once every four days (0.25) result for the remaining units in the support group area. These unit move frequencies are used to generate unit move mission requests in the fleet performance simulation.

Table 3-5

FREQUENCY OF UNIT MOVES AS A FUNCTION OF FEBA MOVEMENT RATE

	Rate of FEBA advance - km per day	Unit moves - per day
Artillery Units	20	2.0
	10	1.0
	5	0.5
	2	0.2
Other Units	20	0.33
	10	0.20
	5	0.10
	2	0.05

CARGO VEHICLE FLEET PERFORMANCE SIMULATION

Introduction

The basic vehicle fleet performance simulation is discussed in Chapter 1 and, in detail, in App. A. This chapter discusses the application of the simulation method in analyzing the fleet performance of both the cargo fleet as currently organized and alternative pooled fleets of varying size and composition.

The central theme of the cargo fleet simulations is the application of mission demands in the form of cargo resupply and unit move assistance missions against the capabilities of both the current and the various pooled fleet alternatives to meet this mission demand. Mission demand is generated by the combat situations set by the LOGEX scenario in the period D+90 through D+104. During this period the first seven days are a general attack along the entire front of the 30th U.S.

Field Army. After the initial week of attack, the 23rd and 25th Armored Divisions which were in reserve in II Corps rear area, move through the areas of the divisions on the line and the posture of II Corps shifts from attack to one of exploitation by the two armored divisions and support of the exploitation by the remaining corps units including those in the 14th Support Group area.

In following this combat scenario a basic simulation run for the units in the 14th Support Group area consists of seven days in the attack posture with the FEBA advancing at 10 kilometers per day, and a second period of eight days in the pursuit posture with a FEBA advance rate of 20 kpd. These combat postures determine the daily resupply tonnages to be delivered to each unit by the cargo fleet. In like manner the FEBA advancement rates determine the number of unit moves which must occur each day and thus the number of unit move assistance missions to be performed by the fleet.

<u>Simulation Inputs</u>

Inputs to the fleet performance simulation for both pooled and current fleets break down into three basic groups, scenario related parameters, mission demand parameters, and vehicle/unit capability parameters.

<u>Scenario Related Inputs</u>. Simulation inputs derived directly from the combat scenario are primarily unit positions on the battlefield and unit move frequencies. These are the UTM grid coordinate positions of the 127 units in the 14th Support Area on the initial day of simulation,* the grid coordinates of the vehicle pool (for the pooled fleet simulation runs) and the coordinates of supply points.

In addition to unit position information, the rate of FEBA movement for each day of simulation must be specified as well as the frequency of move for each of the units.

<u>Mission Input Parameters</u>. Simulation inputs necessary to define missions to be performed are the tonnages of ammunition and other cargo to be delivered daily to each of the units, and the tonnage of equipment and reserve resupply for each unit which must be handled by the cargo fleet in the event of a unit move.** As previously described, unit moves

*See Table C-1, App. C.
**See Tables C-1 and C-2, App. C.

occur on a random or stochastic basis depending on the input frequency of unit moves.

In addition to mission tonnages, the priority of missions must be specified as well as the time of request of missions during the simulation day, and the length of the simulation day itself. Three mission priorities were established for cargo fleet simulation; ammunition resupply missions were priority one, unit move missions priority two, and resupply of other cargo (not to include bulk fuel or repair parts) was priority three. These priorities could, of course, be rearranged, if desired.

The length of the simulation day was set at the standard 20-hour combat day thus allowing two shift operation of cargo vehicles if necessary. Mission request times were set as follows: unit move missions occurring within a given day are requested at the beginning of the day while ammunition and other cargo resupply missions are requested at random times throughout the first 10 hours of the operating day. This request time procedure for ammunition and other cargo missions while not necessarily realistic tends to avoid excessive mission dispatch delay times in the simulation for both the current and pooled fleet. For example, assume that under current fleet organization, a unit logistics officer or non-com knows that he must use the cargo trucks at his disposal for both a unit move and resupply missions. The number of vehicles is not sufficient to accomplish all three missions simultaneously. It is unrealistic to assess delay time from the beginning of the operating day against the resupply missions since they would not be requested until the unit move mission was complete. Thus the random request time procedure for resupply missions was used rather than requesting all missions at the beginning of the operating day.

Vehicle/Unit Input Parameters. Specific vehicle inputs to the simulation are those previously outlined in Table 3-2. In addition to these vehicle payload, cost, maintenance parameters, and the vehicle speed of 40 kph, the other primary vehicle related input parameters are the fleet sizes of the various alternative fleets. Fleet sizes are specified by the number of each vehicle type in the fleet under consideration. Table 3-1 shows the current fleet size by vehicle type and the pooled fleet alternatives are shown in Table 3-6.

Table 3-6

POOLED FLEET ALTERNATIVES

Number of Vehicles

Vehicle type	Linear mix pooled fleets 60%	50%	40%	30%	Remixed fleets[1] A	B
3/4 ton cargo (M37)	44	37	29	22	9	9
3/4 ton cargo (M37) + 3/4 ton cargo trailer (M101)	201	168	134	100	31	27
$2\frac{1}{2}$ ton cargo (M35)	51	42	34	26	58	68
$2\frac{1}{2}$ ton cargo (M35) + $1\frac{1}{2}$ ton cargo trailer (M105)	254	212	169	127	18	13
5 ton cargo (M54)	17	14	12	9	18	13
5 ton cargo (M54) + $1\frac{1}{2}$ ton cargo trailer (M105)	104	87	70	52	225	275
Total vehicle/trailer combinations in pool	671	560	448	336	359	405

1. Fleet remix B is the remixed fleet referred to throughout the summary.

The fleet remix alternatives A and B shown in Table 3-6 derive from the fact that a fleet of vehicles in which the ratios of the various cargo vehicle type remain as they are in the current fleet is not necessarily the optimal vehicle mix for pooled fleet operations. The fleet remix alternatives shown are based upon the frequency distributions of mission payloads to be carried. From these mission payload distributions the total payload tonnage in the capacity range of each vehicle type was calculated and the number of vehicles of each type needed in the mix determined by dividing the total payloads by the type vehicle capacity. This process is illustrated in Table 3-7 for fleet remix A. As can be seen there, once the number of vehicles of each type is determined the total fleet size is reduced by using only about one-half of the 5 ton truck/trailer combinations indicated. The need for two fleet remixes of this sort is due to the two unit move mission payload distributions as discussed in the section on unit move mission demand. Fleet remix A corresponds to the unit move payloads derived from REVAL data while remix B is based on unit move payloads using rated vehicle capacities.

The only remaining simulation input parameters to be specified concern the capacity of units to handle incoming and outgoing resupply or unit move missions. This material loading capacity is specified for each fleet organization, type of mission, and each unit. Material handling capacity is given in each case by the number of loading docks, devices or loading teams (if the material is man-handled), and the rate at which cargo can be handled by each device or team. Table 3-8 summarizes these materiel handling capacities.

The capacities shown are based on a variety of data. The loading capecities for ammunition and other cargo are based on the number of fork-lifts available in the ordnance companies and the general supply support and supply and service companies in the 14th Support Group. Only one-half of the available fork lifts are used for loading vehicles at the vehicle pool or supply points under the assumption that the other fork lifts would be engaged in off-loading incoming line haul vehicles. The loading rate for the fork lifts handling non-ammunition cargo is less than that for those handling ammunition since the ratio of 5:3 ton

Table 3-7

CARGO FLEET REMIX A - DERIVATION

Vehicle type	Payload range-ton	No. of missions in payload range[1]	Total tonnage	Vehicles in remixed fleet
3/4 ton cargo	0-1.0	14	9.03	9
3/4 ton cargo w/tlr	1.1-2.1	42	61.94	31
$2\frac{1}{2}$ ton cargo	2.1-4.0	81	230.00	58
$2\frac{1}{2}$ ton cargo w/tlr	4.0-6.0	40	212.05	18
5 ton cargo	4.0-6.0			18
5 ton cargo w/tlr	6.0	100	4133.00	517(225)[2]
Totals		277	4646.02	651(359)[3]

1. Ammunition and cargo resupply, typical attack posture day.

2. 517 vehicles to carry in one lift the total tonnage in the 6-ton plus range. 225 vehicles used in the fleet simulation.

3. Total vehicles to carry tonnage in one lift. 359 vehicles used in the simulation.

Table 3-8

MATERIALS HANDLING CAPACITY

Loading	Unloading
Pooled fleet - at vehicle pool location	Current and pooled fleets - at unit locations
Ammunition: 20, 3-5 ton fork lifts and cranes @ 1 ton/minute	Ammunition: 1-5 ton wrecker @ 1 ton/minute
Other cargo: 30, 3-5 ton fork lifts @ 0.6 ton/minute	Other cargo: Variable number of 5-man unloading teams @ 0.05 ton/minute
Current fleet - at supply point locations	Unit moves -
Ammunition: 10, 3-5 ton fork lifts @ 1 ton/minute	equipment and supplies: 1-5 man loading team per vehicle in unit move mission @ 0.05 ton/minute
Other cargo: 15, 3-5 ton fork lifts @ 0.60 ton/minute	reserve ammunition in artillery units: 1 - 5 ton wrecker @ 1 ton minute
Current and pooled fleets - at unit locations	
Unit move - equipment and supplies: 1 - 5 man loading team per vehicle in unit move mission @ 0.05 ton/minute	
Unit move - reserve ammunition in artillery units: 1 - 5 ton wrecker @ 1 ton/minute	

fork lifts is greater in the ordnance companies. Loading rates for unit move equipment and supplies are based on rates specified for 5-man loading teams in FM 101-10-1.[4]

Unloading devices and rates are based on the assumption that at least one 5-ton wrecker would be available to off-load ammunition pallets in the artillery battalions trains areas. The number of unloading teams for non-ammunition cargo at each unit location was set at one 5-man team per hundred unit personnel based on a study of TOE personnel lists.

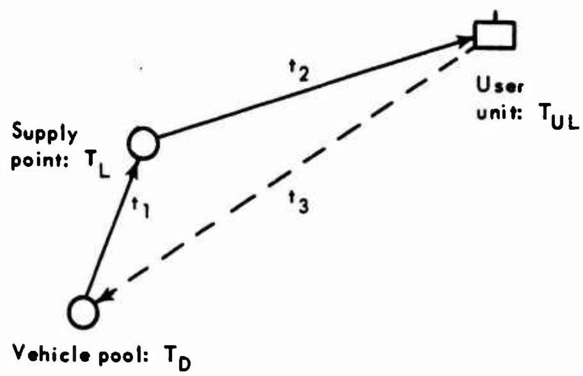
Simulation Output

The total array of vehicle fleet performance output was summarized in Table 1-1, Chapter 1. Those outputs of primary interest for comparison of pooled and current cargo fleet performance are the delay times for dispatch of resupply and unit move missions, and the times required for completion of these same missions. In addition, the time utilization of the various pooled fleets and the current fleet in responding to equal mission demands as generated by the combat scenario are also of interest in determining vehicle availability and driver requirements for the pooled fleet alternatives.

Mission Dispatch Delay. Delay in dispatch of requested resupply or unit move assistance missions is defined as the time from mission request to dispatch of the group of cargo vehicles required to perform the mission. The sources of mission delay are the unavailability of vehicles due to maintenance or the situation that all vehicles appropriate for the requested mission are occupied in performance of missions previously requested or dispatched.

Mission Completion Time. Mission completion time is defined as the time from mission request until the mission is complete. The specific elements which enter into mission completion time vary with fleet organization and the type of mission being performed. Figure 3-3 shows in schematic form the elements of mission completion time for both pooled and current fleet organization and the three basic mission types.

For the pooled fleet, mission completion times for ammunition resupply and other cargo resupply missions (Part a, Fig. 3-3) consist of mission dispatch delay, vehicle group load time, travel time to the resupplied unit, and vehicle group unload time. Travel time of the vehicles

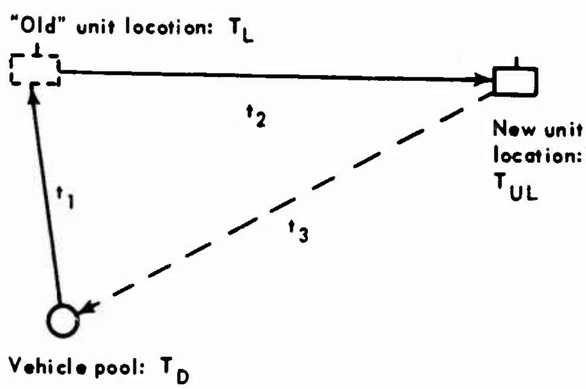


a. Pooled Fleet, Ammunition and Cargo Resupply Missions

$$MCT = T_D + t_1 + T_L + t_2 + T_{UL}$$

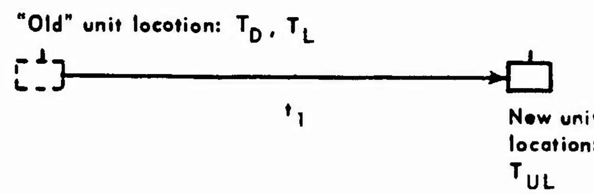
b. Current Fleet, Ammunition and Cargo Resupply Missions

$$MCT = T_D + t_1 + T_L + t_2 + T_{UL}$$



c. Pooled Fleet, Unit Move Assistance Missions

$$MCT = T_D + t_1 + T_L + t_2 + T_{UL}$$



d. Current Fleet, Unit Moves

$$MCT = T_D + T_L + t_1 + T_{UL}$$

Fig. 3-3—Mission Completion Time Definitions

MCT – mission completion time

T_D – mission delay in dispatch

T_L – vehicle load time

T_{UL} – vehicle unload time

t_1, t_2, t_3 – elements of travel time in order of occurrence

$\longrightarrow$ travel time included in MCT

— — → travel time not included in MCT

as they return to the vehicle pool is not included since the mission is complete when the unit requiring resupply has received the material requested. Return travel time does, however, contribute to overall mission delays (and thus ultimately to mission completion times) since the vehicles are unavailable for use in other missions during this period.

Figure 3-3, Part b shows the elements that make up mission completion time for ammunition and other cargo missions under current fleet organization. These elements include mission dispatch delay at the supply point, return travel time to the unit, and vehicle group unloading time.[13] As can be seen, current fleet organization produces inherently longer mission completion times for resupply missions in that the inclusion of two legs of travel time is necessarily included in the time to deliver and unload the requested resupply.

In like manner, an inherent time disadvantage for mission completion of unit moves is present under pooled fleet organization. As shown in Fig. 3-3, Part c and d, mission completion time for unit move assistance missions by pooled cargo vehicles includes mission dispatch delay, travel time to the "old" unit location, loading time for vehicles, travel time to the new unit location, and vehicle unload time. Mission completion time under current fleet organization only includes load time, travel to the new unit location, vehicle unload time and, of course, any delays in mission dispatch due to vehicle maintenance or occupation with other missions.

Time Utilization of Vehicle Fleets. This series of output parameters simply summarizes the total operating, idle, load-unload/and maintenance times for each alternative fleet of cargo vehicles over the period of simulation, and is useful supplementary information for the fleet planner in comparing alternative fleets.

Cargo Fleet Performance Simulation Results

This section presents the results of simulation runs made using the alternative vehicle fleets, current and pooled, shown in Tables 3-1, and 3-6. All simulation runs were made under the mission demands generated by the LOGEX scenario previously described. This resulted in a 15-day basic simulation run with 7 days of attack posture and eight days of pursuit or exploitation. This combat scenario called for rates of FEBA advance of 10 and 20 kilometers per day and corresponding unit move frequencies.

The results shown in this section compare the mission dispatch delays, mission completion times, and vehicle time utilization figures for each of the alternative fleets considered. As was found in the previous study of vehicle pooling, consideration of these vehicle fleet performance parameters in average value form can be misleading in that the form of the total distribution of delay times or mission completion times is not indicated by average values. For this reason, all results in this report are shown in the form of cumulative curves.

Mission Dispatch Delays

Figures 3-4 , and 3-5 show cumulative percentages of all mission types (ammunition and cargo resupply, unit moves) dispatched as a function of time from request to mission dispatch. Each curve in the figures represents the percentage of all missions dispatched at a given point in time for each of the alternative cargo vehicle fleets. The two figures are based on two sets of simulation runs identical except for unit move payloads. The mission delays shown in Fig. 3-4 are based on unit move payloads derived from REVAL data while the unit move payloads for the simulations which produced the curves in Fig. 3-5 are based on each cargo vehicle participating in a unit move being loaded to its rated (off-road) capacity. This parameterization of unit move payloads will only be shown in these two figures. For the sake of conciseness, the results presented for each of the mission types and the mission completion time results will only be shown for simulation runs made with the heavier (rated vehicle capacity) unit move payloads while figures showing results from runs made with the REVAL derived unit move payloads are given in App. D.

Readily apparent from the two figures is the fact that the cargo fleet as currently organized experiences only a small percentage of missions delayed in dispatch, with 95 percent of all missions requested dispatched with no delay. When missions are delayed, however, delays are considerable with 100 percent of missions dispatched only after 7-8 hours from time of request. Considering the curves for pooled fleet alternatives in Fig. 3-4 (light unit move payloads), the 40 percent pooled fleet and the remixed pooled fleet (remix A) provide mission

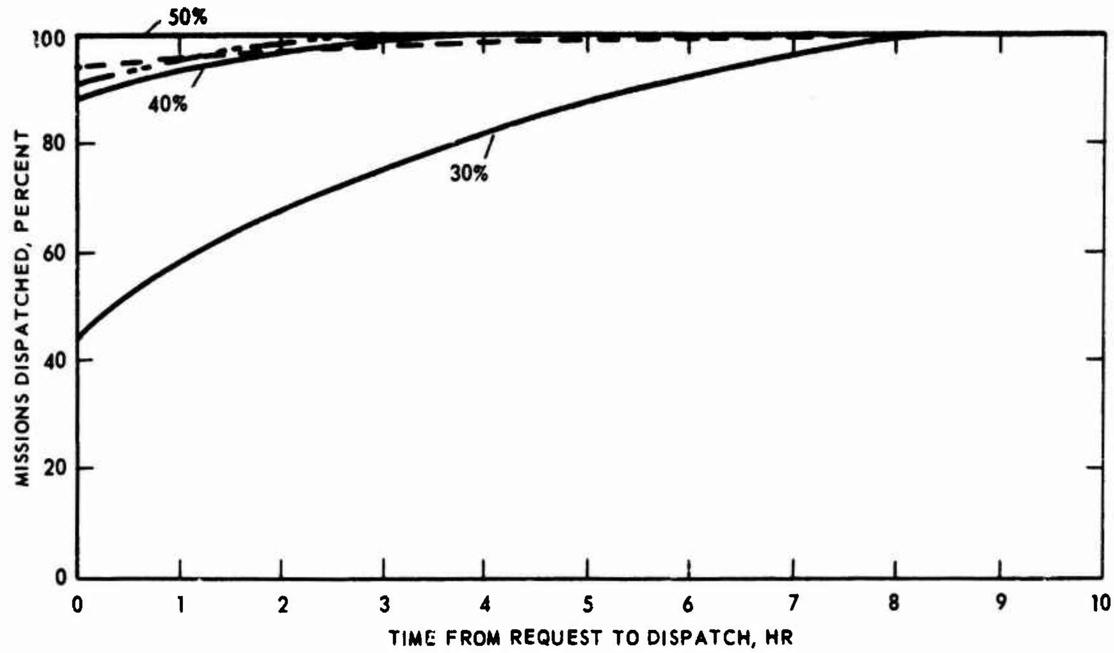


Fig. 3-4—Cumulative Mission Dispatch Times—All Mission Types

Light unit move payloads.

— — — Current fleet ——— Pooled fleet —··— Fleet remix A

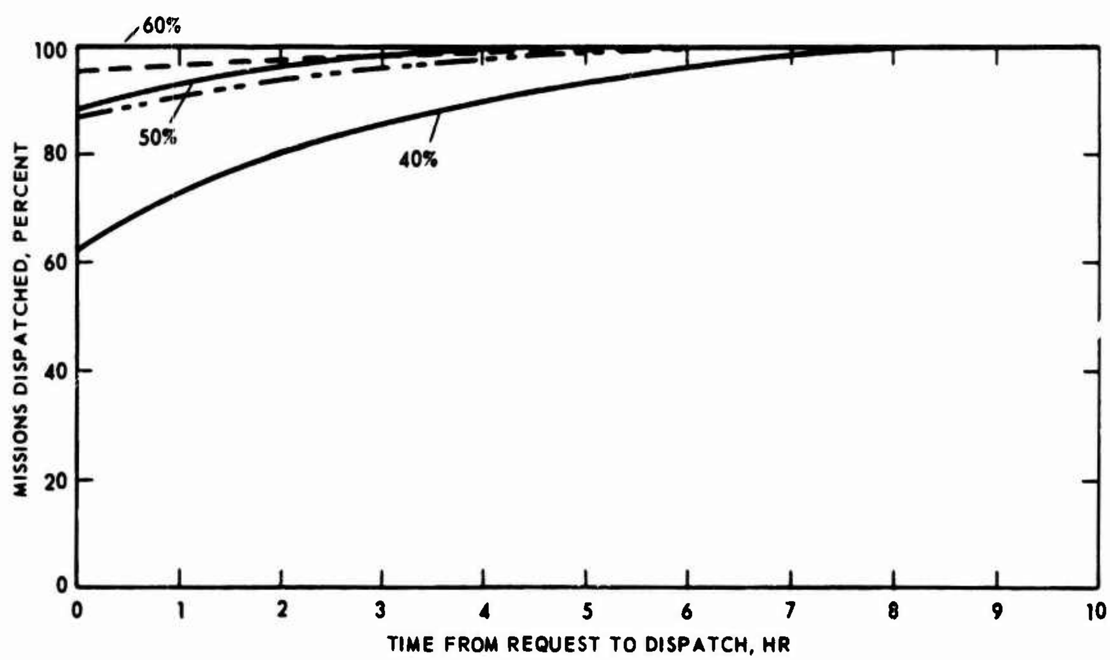


Fig. 3-5—Cumulative Mission Dispatch Times—All Mission Types

Heavy unit move payloads.

— — — Current fleet ——— Pooled fleet —··— Fleet remix B

delay distributions comparable to the current fleet with around 90% of all missions dispatched with zero delay and all missions dispatched in less than 4 hours. The 30% pooled fleet experiences considerably more mission delay than the current fleet while the 50 and 60% pooled fleets suffer no mission dispatch delay at all.

The results of the simulation runs using the heavier unit move payloads (Fig. 3-5) show a predictable trend toward more mission dispatch delays for the pooled fleet alternatives under the increased mission demand. In this case the performance of the 50% pooled fleet and fleet remix B is more comparable to that of the current fleet with the 40% fleet showing much greater mission delays than the current fleet. On the basis of these results (with the heavier unit move payloads) it could be concluded that fleet performance equal to the current fleet is achieved by fleet remix B and the 50% pooled fleets with respect to mission dispatch delay. The figures which follow, 3-6 through 3-8 present simulated fleet performance in terms of mission delay for the three basic mission types considered separately. In almost every respect these results for ammunition and other resupply, and unit move missions are consistent with the aggregated results shown in Fig. 3-5. A significant fact is the small percentage of missions delayed at all except for the 40% pooled fleet. With that exception, no more than 15% of requested missions are delayed by the performance of the alternative fleets and (with the same exception) over 95% of all missions are dispatched in three hours or less.

Mission Completion Times

From the viewpoint of the user unit requesting vehicle services, mission completion times are the fundamental fleet performance parameter. These times dictate the unit's receipt of cargo and assistance in unit moves and directly affect the unit's ability to perform. For these reasons the fundamental parameter influencing fleet size and organization decisions should probably be this time from request of mission to completion of the service desired.

Figure 3- shows the cumulative mission completion time curves for the current and alternative pooled cargo fleets. These curves are aggregated over all mission types. Interpretation of the mission

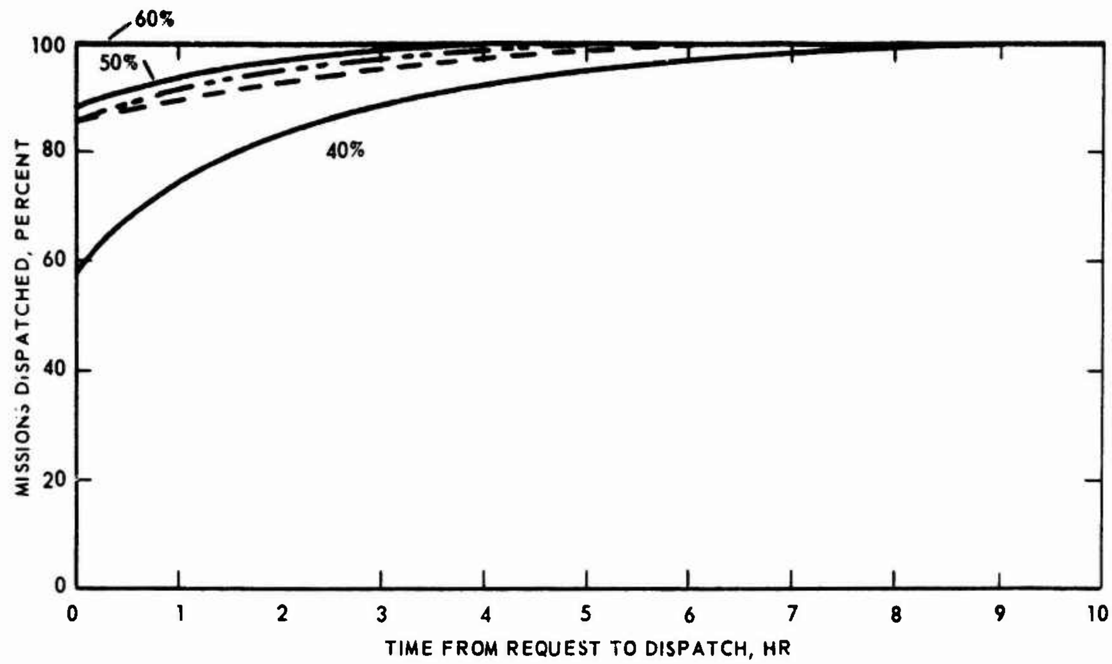


Fig. 3-6—Cumulative Mission Dispatch Times—Ammunition Resupply

— — — Current fleet ——— Pooled fleet —·· — Fleet remix B

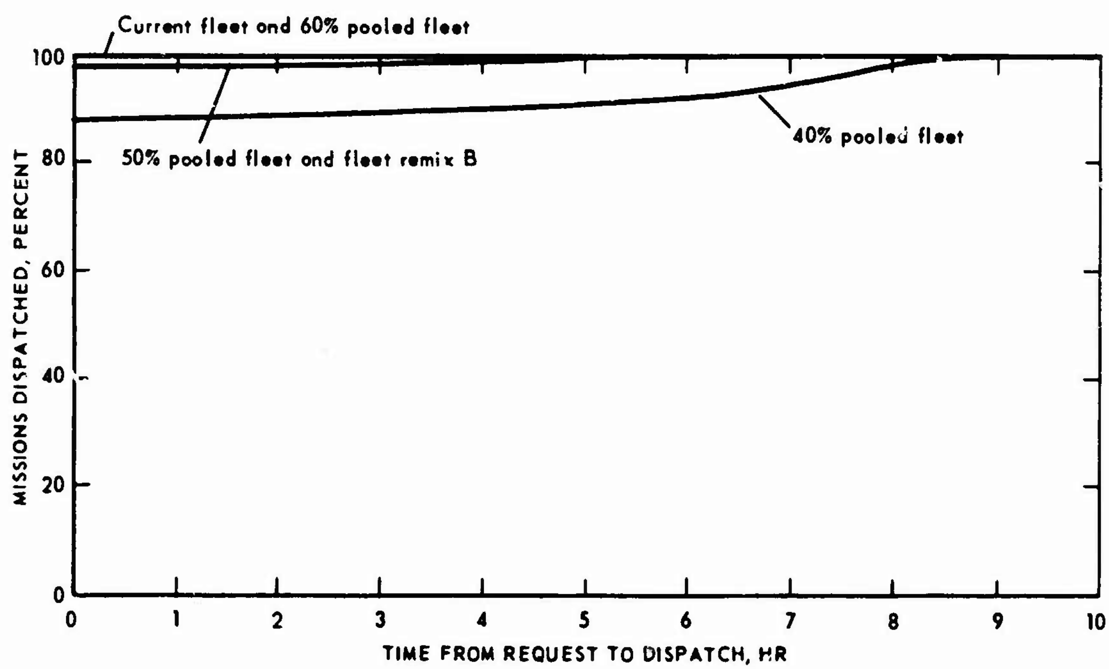


Fig. 3-7—Cumulative Mission Dispatch Times—Unit Moves

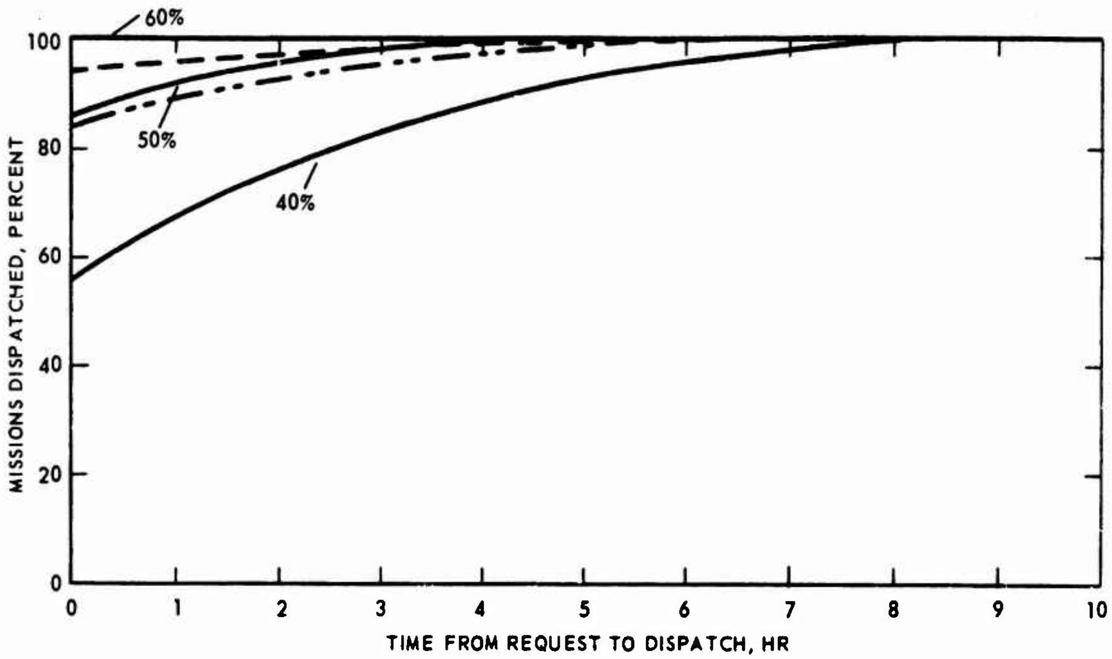


Fig. 3-8—Cumulative Mission Dispatch Times—Cargo Resupply

— — — Current fleet ——— Pooled fleet —··— Fleet remix B

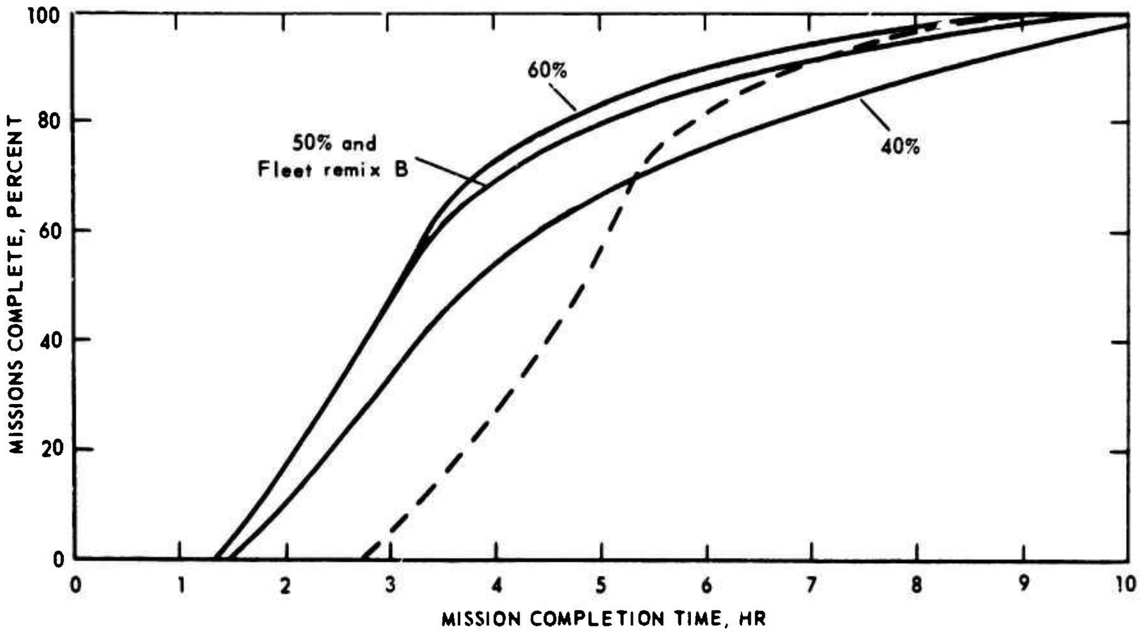


Fig. 3-9—Cumulative Mission Completion Times—All Mission Types

— — — Current fleet ——— Pooled fleet

completion time results is nowhere as simple as were the results for mission dispatch delay since the form of the completion time distributions is considerably different for the current fleet versus the pooled fleet alternatives.

With the exception of the 40% pooled fleet all missions are completed in 10 hours or less and 90% completed in 7 hours or less by both the current and pooled fleets. Below this point in time however, the added travel time for ammunition and cargo resupply missions experienced by the current fleet constrains the point at which missions begin to be completed to around 3 hours or more. Since pooled fleet vehicles have only the one-way travel time (pool to user unit) included in mission completion time some missions can be finished as quickly as $1\frac{1}{2}$ hours. The inherent advantage of current fleet organization in completing missions of the remaining type, unit move asistance, does not offset completely the pooled fleet advantage in cargo delivery. This is due to the fact that while ammunition and cargo resupply missions occur daily, unit move missions are not so frequent and influence the total distribution of mission completion times to a lesser degree.

A clearer picture can be gained by considering mission completion time results separately for the three mission types. These results are shown in Figs. 3-10, 3-11, and 3-12. As would be anticipated, the pooled fleet alternatives complete ammunition and other cargo resupply missions considerably faster than does the current fleet (with the exception to a degree of the 40% pooled fleet in the delivery of cargo). In completing unit move missions however, none of the pooled fleet alternatives can match the performance of the current fleet in completing all unit moves in 8 hours or less. Fleet remix B and the 50% (and 60%) pooled fleets do complete 95% of requested unit move missions in less than 10 hours and 100% in 12 hours or less.

In assessing overall fleet performance for the three mission types, it would seem that the mission completion times provided by fleet remix B or the 50% pooled fleet are acceptably close to current fleet performance if 95% completion of unit move missions in 10 hours or less is permissible. This should be compared with 95% unit move completion by the current fleet in 7.5 hours. On the other hand the

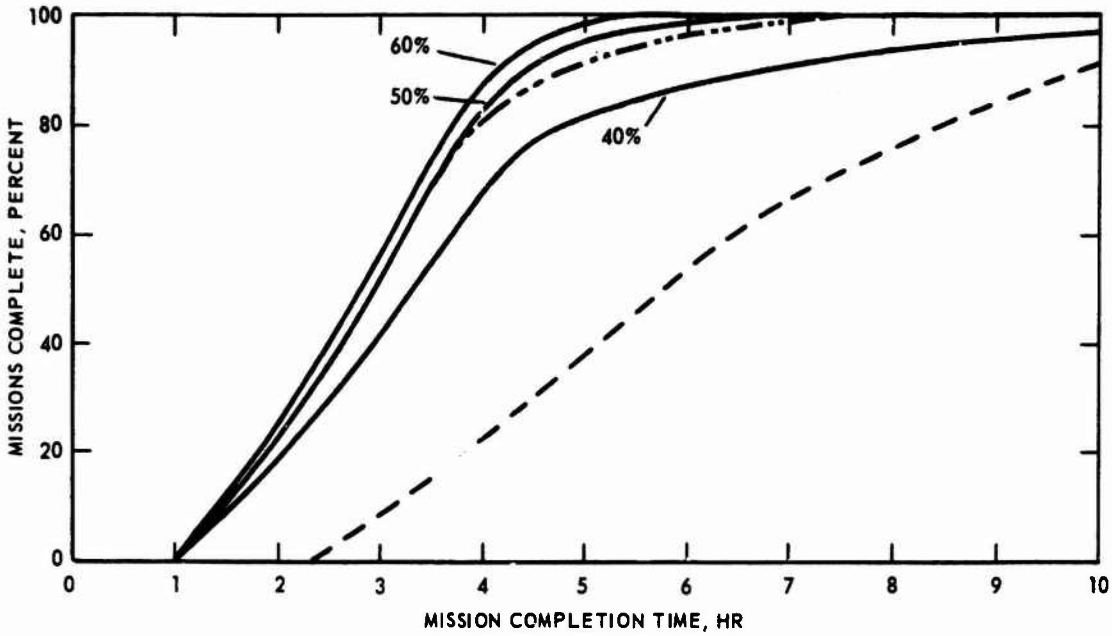


Fig. 3-10—Cumulative Mission Completion Times—Ammunition Resupply

— — — Current fleet   ——— Pooled fleet   —··— Fleet remix B

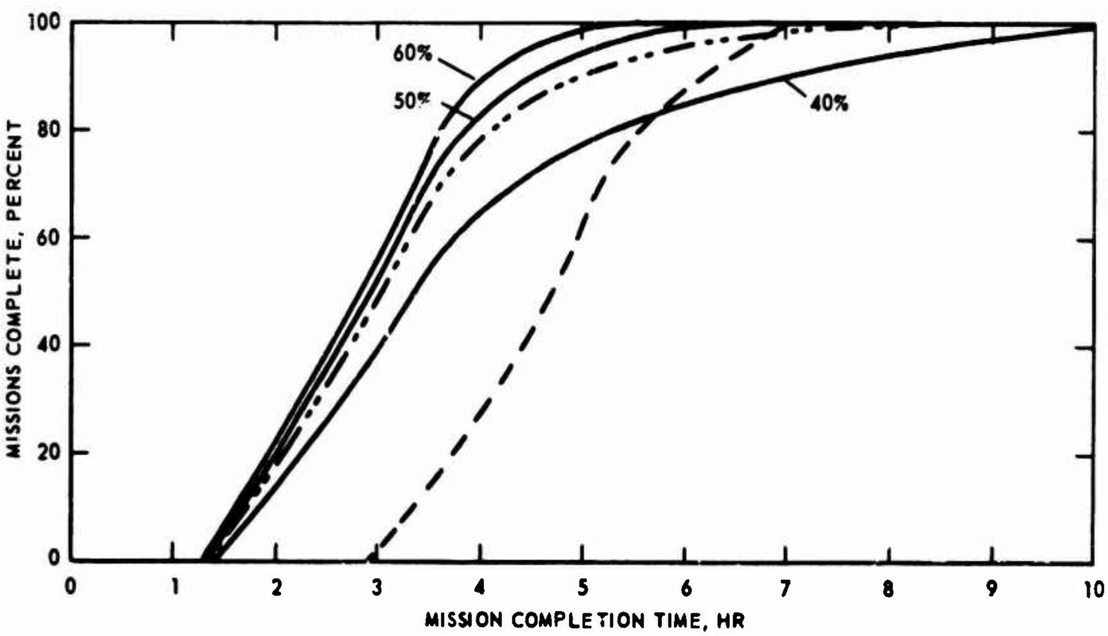


Fig. 3-11—Cumulative Mission Completion Times—Cargo Resupply

— — — Current fleet   ——— Pooled fleet   —··— Fleet remix B

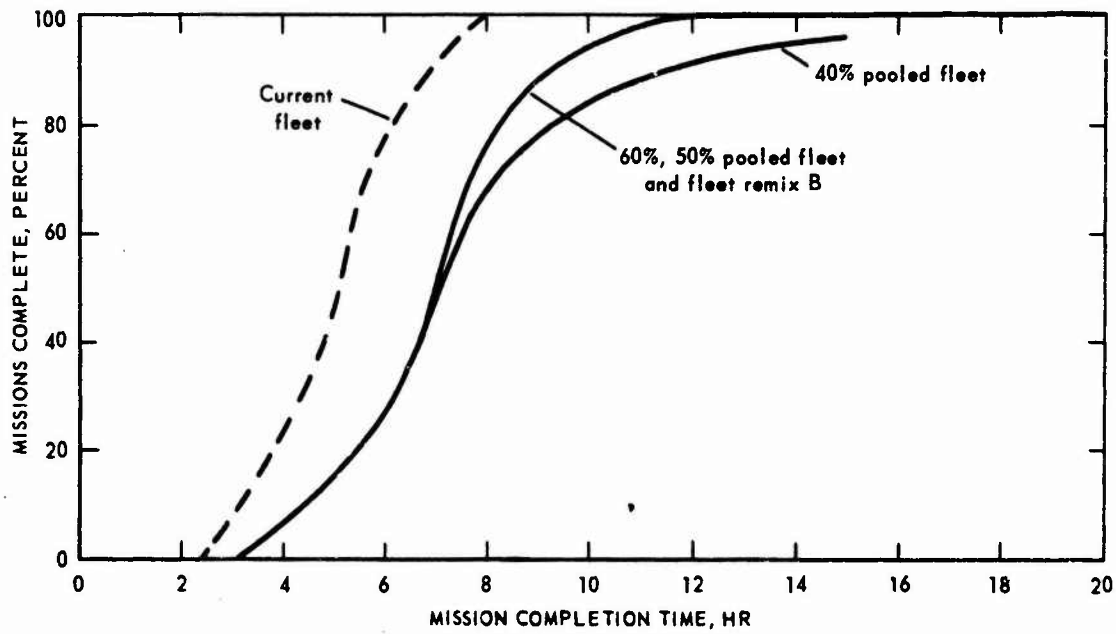


Fig. 3-12—Cumulative Mission Completion Times—Unit Moves

two pooled fleet alternatives provide considerably faster completion of ammunition and cargo resupply missions. Ninety five percent of these missions are finished within 5.5 hours as compared with 6.5 hours for cargo and greater than 10 hours for ammunition under current fleet organization. In summary it would seem that at least equal (simulated) fleet performance is provided by fleet remix B or the 50% pooled fleet compared to the current fleet except for unit move missions.

Sensitivity Analysis

Since the simulation model used in this study has been completely checked out in previous work,[7] sensitivity testing of the model itself was not done for this report. Several additional simulation runs were made, however, to test the effect of varying the simulation input data. These runs included the parameterization of vehicle speed, vehicle maintenance factors, and unit move frequencies.

In each case the results of the simulation runs were predictable. Changing inputs in such a manner that the vehicle fleets were more heavily taxed in usage (i.e., decreasing vehicle speed, increasing maintenance, and increasing the number of unit moves) produced greater mission delays and longer mission completion times. The opposite effect was seen, of course, when the input parameters were changed to decrease demand on vehicles in the fleet. In all cases the relative performance relationships between pooled and current fleets remained about the same. The central point is that such parameterization of important input variables is quickly and easily done once a pooling problem is formulated and the basic input data collected.

Vehicle Fleet Time Utilization

Results produced by the fleet performance simulation on the time utilization of cargo vehicles in the alternative fleets are of primary interest in portraying the availability of vehicles for use in performing missions. In addition, the operating and load/unload hours required by each alternative in meeting mission demand are of utility since this latter combination of parameters is important in determining the required number of drivers for the pooled fleets as will be seen in the next section.

Figure 3-13 gives the vehicle time utilization profile for all of the alternative fleets. On the vertical axis, total time can be interpreted as the sum over the total duration of the simulation runs (15 days) or viewed as an average daily total time. In either case, 100% total time is the number of vehicles in the fleet times 24 hours per day (times 15 days if considering the total simulation run). The horizontal axis shows average vehicle operating time per day in hours with the various fleet alternatives shown at their respective values.

The most notable aspect of Fig. 3-13 is the large percent of idle time shown by all of the alternative fleets. Two points are important in interpretation of idle time as shown. The first is that all of the time shown is not strictly vehicle idle time in the sense that the vehicles are sitting immobile. Rather it is the time left over when all of the times for known activities such as maintenance, travel on missions, and load/unload are subtracted from total time. It is probable that the vehicles are occupied during a significant portion of this "idle time" by such activities as travel to and from maintenance facilities, fueling at the end of a work day, etc. The second point is illustrated by the fact that a sizable percentage of idle time is present even for the pooled fleet remix alternative which is a quasi-optimized fleet in terms of vehicle type-mission payload matching. What is happening is that idle time is being generated for vehicles by less than optimal mission scheduling. Explained in another way, vehicle idle time results when the improper mix of vehicles is present to service the mission requests at any given moment in time.

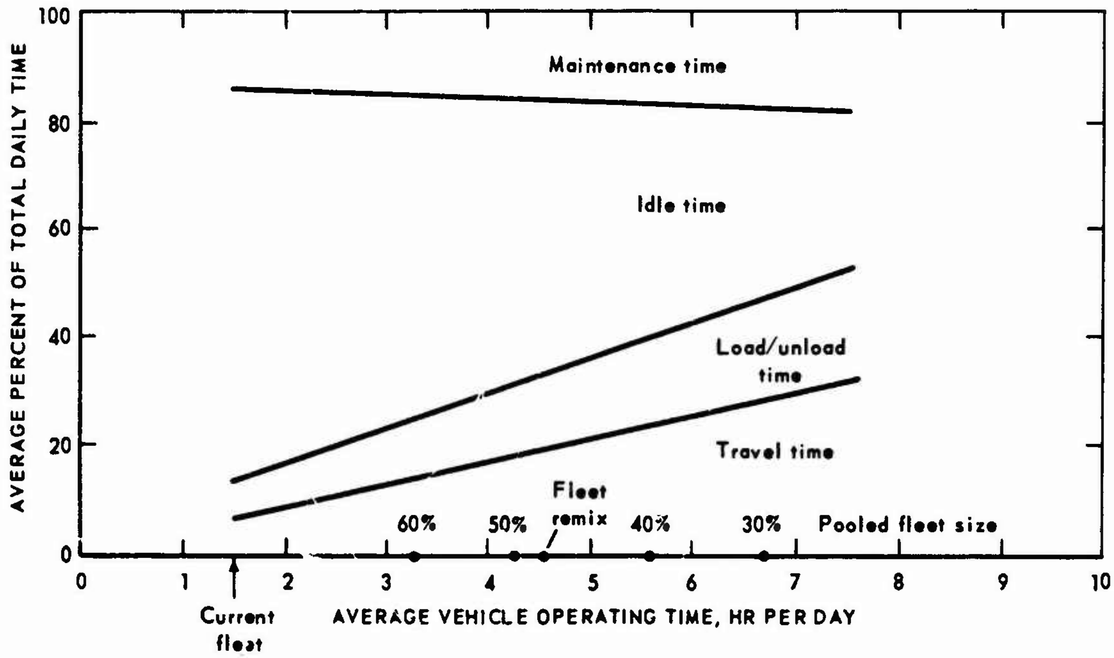


Fig. 3-13—Vehicle Time Utilization Profile

The preceding discussion notwithstanding, it is hard to accept that the current fleet, for example, is "idle" 73% of total time. To verify that this is true however, it is only necessary to look at the number of driver hours available under current fleet organization. With 507 full time drivers working a 10-hour shift and 612 additional duty drivers working an average of 1.16 hours* per day, the total number of driver hours available is 5780 per day. The 1119 vehicles of the current fleet have a "total time" for one day of 26,856 hours (1119 x 24). The number of driver hours available is only 21.5% of total time, leaving 79.5% of total time in which the vehicles must be "idle" or in maintenance. Subtracting the 14% maintenance time leaves a 65.5% idle time figure for the current fleet; not unreasonably far from the 73% shown in Fig. 3-13.

With these points of explanation covered, the remaining essential point of interest from Fig. 3-13 is that vehicle availability (total time minus maintenance time) averages between 80 and 85%, about that expected from corps service area vehicles.

COST COMPARISON OF CURRENT POOLED FLEETS

Introduction

The results of fleet performance simulation indicate that with regard to mission delay, mission completion times, and vehicle availabilities, the performance of the 50% pooled fleet (linear reduction by vehicle type), the fleet remix B and the fleet as currently organized are approximately equal.

It must be emphasized that this equality of simulated fleet performance is relative rather than absolute. That is, the simulated performance of the current fleet and the pooled fleet alternatives are based on common assumptions regarding level of mission demand, vehicle characteristics including maintenance factors and speed, mission load/unload assumptions, etc. throughout the analysis.

* The figure of 1.16 hours/day of driver time for additional duty drivers is based on the cost ratio of $1000 per year to $8600 for assigned drivers. Since 11.6% of the cost of a full time driver is allocated to fleet cost for additional duty drivers, the same percentage of a 10-hour, full time shift (1.16 hours) was allocated to total driver time.

This does not mean that the fleet performance parameters such as mission delay and completion time are absolutely correct since this is a function of the values of the inputs common to all simulation runs. While every effort has been made to validate simulation input data, actual comparison of pooled versus current fleet performance can only be achieved through field test exercises. With this cautionary note, however, it is appropriate to proceed with an analysis of the comparative costs of the current and pooled cargo fleet alternatives.

Cost Elements

The costs to be considered in the direct comparison of the current cargo fleet and the 50% pooled and fleet remix B alternatives are the vehicle costs on a 12-year life cycle basis and the driver costs. Other costs such as reduction in maintenance costs for the smaller pooled fleets and the added cost of command and control elements for the pooled fleets are most difficult to obtain and can only be noted in the present study.

Alternative Fleet Vehicle Costs. Table 3-9 shows the number, type, and cost (including totals) of the vehicles in each of the three alternative cargo fleets. These 12-year life cycle costs are the latest available from the ACSFOR REVAL WHEELS Study.[1] As seen the costs of the vehicles alone (not including driver costs) of the two alternative pooled fleets are about half the cost of the current fleet. In terms of vehicle numbers, the fleet remix requires far fewer vehicles for "equal" performance than does the 50% pooled fleet; 36% of the number used by the current fleet. This assumes importance in comparing total fleet costs in which driver costs dominate.

Driver Costs

Data extracted from the REVAL WHEELS Study shows a total of 507 drivers assigned to the vehicles of the current fleet for units in the 14th Support Group area. This does not include drivers assigned to line haul transportation units, of course, since these vehicles were not included in simulation of current fleet performance. The remaining 612 vehicles of the current fleet are driven by additional duty drivers. The latest cost data available to the study team[1] place the cost of an assigned driver at $8600 per year and the cost of an additional duty driver at $1000 per year (a ratio of 8.6:1). In terms of 12-year costs

Table 3-9

ALTERNATIVE FLEET VEHICLE COSTS[1]

Vehicle type	Unit cost($K)	Alternative fleet					
		Current		50% Pooled fleet		Fleet remix B	
		No.	Cost($K)	No.	Cost($K)	No.	Cost($K)
3/4 ton cargo	23.8	73	1,737.4	37	880.6	9	214.2
3/4 ton cargo + tlr	27.2	335	9,112.0	168	4,569.6	27	734.4
$2\frac{1}{2}$ ton cargo	35.3	85	3,000.5	42	1,482.6	68	2,400.4
$2\frac{1}{2}$ ton cargo + tlr	38.9	423	16,454.7	212	8,246.8	13	505.7
5 ton cargo	52.9	29	1,534.1	14	740.6	13	687.7
5 ton cargo + tlr	56.5	174	9,831.0	87	4,915.5	275	15,537.8
Total vehicles and costs		1119	41,669.7	560	20,835.7 (50% of current costs)	405	20,080.2 (48% of current costs)

1. All costs are 12-year life cycle.

to correspond to 12-year life cycle vehicle costs, the driver costs are $103,200 and $12,000 respectively. On this basis total driver costs for the current fleet are 59.6 million dollars.

Assessment of the number of drivers and thus driver costs for the pooled fleet alternatives to the current fleet poses problems. Drivers could be assigned on the basis of vehicle availability which would result in a ratio of 1.68 drivers per pooled vehicle using the 84% vehicle availability from Fig. 3-13 and assuming two-shift fleet operations. Consideration of this same figure, however, shows that even though vehicles are available 84% of total time, their actual operation time (travel + load/unload) is much less, around 32% of total time. Assigning drivers on this average operating time basis is just as unrealistic, however since it would result in less than one driver per vehicle. Study of detailed day by day simulation output shows that on peak demand days (many unit moves) all vehicles are in use simultaneously, thus requiring at least one driver per vehicle.

Consideration of this same simulation output allows an assessment of pooled fleet driver needs on the basis of vehicle operating and load/unload hours on peak mission demand days. On the peak demand days of the simulation 5740 such hours were required by the 50% pooled fleet and 4285 hours by the fleet remix alternative. On the basis of 10-hour shifts this would imply a need for 574 and 429 drivers, respectively. Of the procedures outlined for determination of drivers for pooled cargo fleets, this latter procedure is probably most realistic provided an added cushion of drivers is available in addition to the numbers obtained based on peak day operating hours.

Figure 3-14 shows the total (12-year life cycle) driver costs of both pooled fleet alternatives and for two alternative driver costing ratios for the current fleet. Looking first at the cost curves for the pooled fleet alternatives which range from a ratio of 1.0:1 to 1.5:1 assigned drivers per vehicle, the driver costs are seen to range from 42 to 62.5 million dollars for the fleet remix alternative and 57.5 to 86.5 million for the 50% pooled fleet. This is in comparison to total driver costs for the current fleet of about 60 million dollars if additional duty drivers are costed at $1000/year or 83.5 million if these

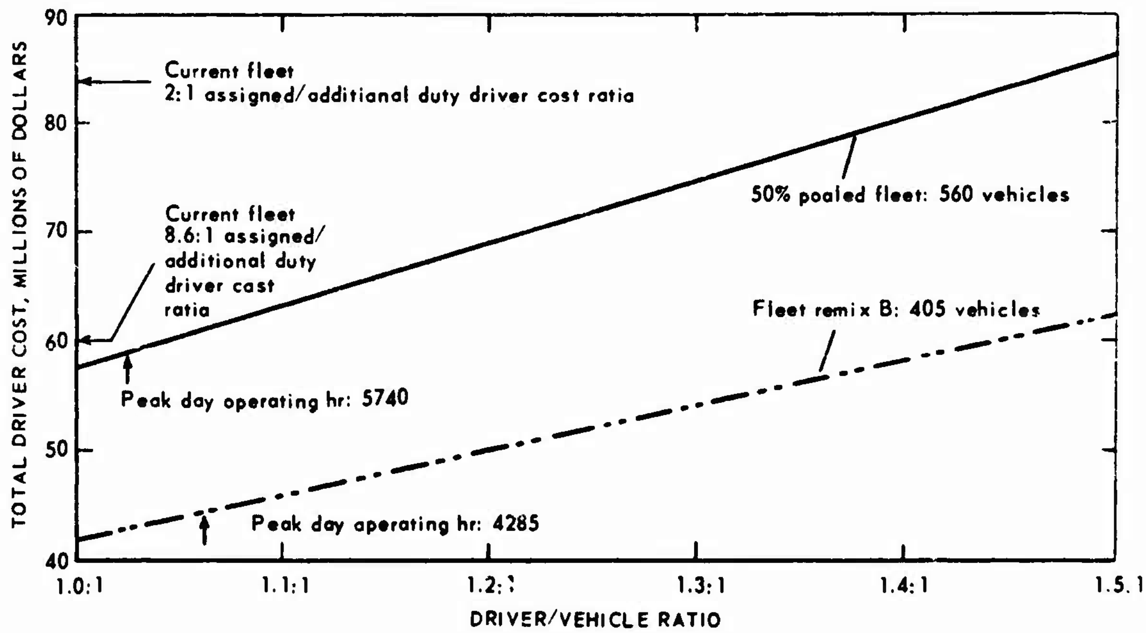


Fig. 3-14—Comparative Driver Costs—Current vs Pooled Cargo Fleet Alternatives

same drivers were costed at $4300 a year (one-half the assigned driver costs).

Indicated on the driver cost curves for the pooled fleet alternatives are the driver ratios generated by peak day vehicle operating and load/unload hours. Ratios for both alternatives are less than 1.1 drivers per vehicle. To be conservative in estimating driver numbers and costs, ratios of 1.1 and 1.2 drivers were used in the next section which considers total fleet costs.

Total Fleet Cost Comparisons

Figure 3-15 shows (in format similar to Fig. 3-14) the total fleet costs of the current fleet and the pooled fleet alternatives. These costs combine the vehicle and driver cost elements discussed in preceding sections. Of primary interest is the relative total cost of the fleet remix alternative in comparison to the current fleet cost using the driver cost ratio from the REVAL WHEELS Study (8.6:1 or $8600/year for assigned drivers versus $1000/year for additional duty drivers). If a ratio of 1.1 drivers to pooled vehicles is sufficient the total cost differential between the pooled remix alternative and the current fleet is on the order of $40 million. If a driver ratio of 1.2 to one is necessary this cost saving drops to $31 million.

Considering the cost curve for the 50% pooled fleet (linear reduction of vehicle numbers per type), cost differentials compared to current fleet cost are much less, $17.5 million and $11.5 million for the two pooled fleet driver ratios. Significant total fleet cost savings seem possible, however, especially using the remixed pooled vehicle fleet. The $31 million dollar cost differential at a 1.1 to one driver/vehicle ratio is a 30% savings in total fleet costs.

If, as may be the case, the costing of additional duty drivers under current fleet organization is inaccurate and these unassigned drivers spend more than 11.6% of their time ($1000 ÷ $8600 in dollar terms) in driving cargo vehicles, savings through vehicle pooling could conceivably be much greater. This is indicated by the current fleet total cost shown in Fig. 3-15 based on one-half time spent in driving by the additional duty drivers. If this were the case, an additional savings increment of $22 million would be added to each cost savings discussed above.

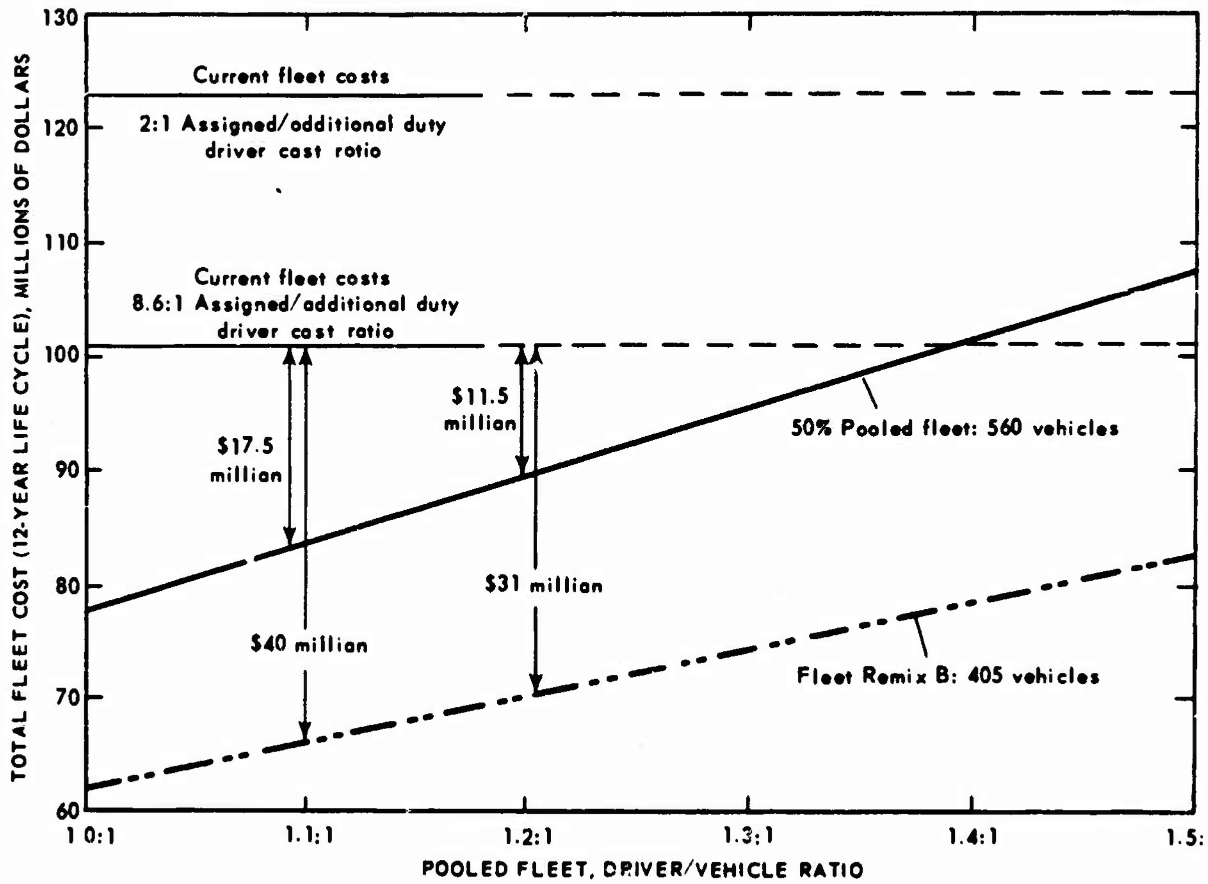


Fig. 3-15—Comparative Costs—Current vs Pooled Cargo Fleet Alternatives

In spite of the complexity and uncertainties of the arguments just presented on pooled versus current cargo fleet costs, two central points emerge from the entire cargo vehicle pooling analysis. First, a method has been developed that allows quick and straight-forward comparison of alternative fleet performance. Second, in spite of uncertainty factors in vehicle and driver data cost elements, indications exist that large dollar savings are possible through vehicle pooling provided simulation results are borne out by field tests and gaming exercises employing pooled fleets.

Chapter 4

TANKER VEHICLE POOLING

INTRODUCTION

Bulk liquid transport (REVAL task type 3.2) was initially selected for analysis of pooling opportunities because of the large percentage of total field army vehicle assets engaged in the task and the apparent excess of tanker capacity. This excess appeared in contrasting tanker capacities to the daily demand for bulk fuel of field army units in peak demand combat postures. More detailed study of the task and associated vehicles showed, however, that due to the dual nature of missions performed by tankers (both transport of bulk fuel and storage at unit location), the approach to tanker vehicles pooling analysis must be somewhat different than that used for cargo vehicles in that those tankers in use as storage tanks must remain with consuming units. In addition, current organization of tanker vehicle assets within the field army and specifically in a corps support group area has already pooled a large percentage of the available tanker assets in the petroleum supply companies and the supply and service companies.

The analysis which follows thus examines first the tanker capacity available in the 14th Support Group area and contrasts this capacity to peak daily demand for resupply of bulk fuel. The performance of that portion of the tanker fleet already pooled under current organization (25%) is then simulated as a base case of fleet performance. Those tankers currently used as mobile storage facilities and filling stations within using units are then examined and the fleet performance consequences of pooling a portion of these vehicles are analyzed for potential vehicle savings.

TANKER VEHICLE ASSETS AND PEAK RESUPPLY DEMANDS

Table 4-1 shows the tanker vehicle assets of the units located in the 14th Support Group area (and forward in division areas) and the peak daily bulk fuel resupply demands of fuel consuming units as extracted from the LOGALOC II study[5] and the AFPG-E.[6] Vehicle assets are grouped by units engaged in line-haul bulk liquid handling, area service units, and the remaining units, i.e., those consuming the fuel delivered.

As is apparent from the table many units have no organic tankers and must be served by the current supply and service company and petroleum supply company tanker pool. This current pool comprises 25.5 percent of the total* tanker assets in the corps support group area. Most of the remaining consuming units have organic tanker capacity less than or about equal to one days consumption at peak demand. Pooling of all these vehicles would deny the user units any mobile bulk fuel storage or mobile filling station capability for topping off unit vehicle gas tanks. The only possibility for further vehicle pooling and thus reduction of vehicles would seem to be the removal of some tankers and drivers from those units having two or more organic tankers and allowing the remaining tanker(s) to act as mobile filling stations while relying on very responsive resupply from the vehicle pool to offset the need for fuel storage facilities. Another possibility is the addition of collapsible fabric fuel drums to those units from which tankers are pooled. In any case the existence of a highly responsive pooled petroleum supply capability seems essential. With these facts in view it was decided to simulate the performance of the current pool of tanker vehicles as a base case and an alterntive pool consisting of the current pool thus a number of tankers removed from those units having more than one tanker as described above. This augmented pooled fleet comprises 45 percent of total tanker assets. Comparison of the performance of these two fleets provides insight into any possible reductions in the tanker fleet through pooling.

*Tanker vehicles organic to line haul units excluded.

Table 4-1

TANKER VEHICLE ASSETS AND
BULK FUEL RESUPPLY DEMANDS

TOE-Unit	No. in 14th supt. gp. area	Tankers per unit					Total capacity: ton/unit	Peak daily resupply: ton/unit
		2½ ton	2½ ton+tlr	5 ton	5 ton+tlr	15 ton (5000 gal)		
Line Haul Units								
55-188 Tran mdm trk co	2					61	915.0	*
Area Service Units								
10-448G Petl sp co fwd	1		18			30	567.0	*
10-476G Hhc petl sup bn	1							2.1
29-217G Sup & service co	1	9				9	171.0	*
Consumer Units								
1-77G Air mbl co lt	2		6				39.0	52.0
1-111T Avn air wpns co	1		4				26.0	52.0
1-1287 Avn air survl co	1		4			1	41.0	52.0
1-252G Hhc avn gp	1		1				6.5	2.0
1-256G Hhc avn bn	2						0	2.0
1-258G Avn med hel co	2		4				26.0	98.0
3-267G Cml smoke gen co	3						0	4.0
5-35G Eng cmbt bn	6	2	6				47.0	46.0
5-52G Hhc eng cmbt gp	1		1				6.5	3.0
5-58G Eng lt eq co	2	1					4.0	18.0
5-64T Eng aslt brg co	2	1					4.0	5.0
5-77E Eng pnl brg co	2		1				6.5	3.0
5-78G Eng flt brg co	1	3					12.0	6.0
5-124G Eng dump trk co	1	1					4.0	4.0
5-327G Eng topo co	1		1				6.5	4.0
6-401G Hhb FA gp	3	1					4.0	3.5
6-415G 8 in how bn sp	5			2			10.0	8.3
6-425G 155 how bn tow	2				2		16.0	6.7
6-435G 175 gun bn sp	3			2			10.0	12.0
6-455G 155 how bn sp	4				3		24.0	9.4
6-501G Hhb corp arty	1						0	5.4
6-525E HJ bn	2			2			10.0	10.5
6-555G Sgt bn	1				2		16.0	9.7
6-575E Tgt acq bn	1	1	4				30.0	20.0
8-122G Hhd med gp	1						0	1.0
8-126G Hhd med bn	1						0	1.0
8-127G Med amb co	2						0	2.6
8-128G Med clrng co	1						0	3.4
8-137G Med air amb co	1		4				26.0	
8-571E Mob ar surg hosp	3						0	3.0
8-581E Evac hosp	2						0	8.2

*Not included - part of POL or cargo distribution system.

Table 4-1 (Cont'd)

TOE-Unit	No. in 14th supt. gp. area	Tankers per unit: $2\frac{1}{2}$ ton	$2\frac{1}{2}$ ton+tlr	5 ton	5 ton+tlr	15 ton (5000 gal)	Total capacity: ton/unit	Peak daily resupply: ton/unit
9-17G Ord ammo ds/gs co	3						0	8.1
9-47E Ord sp ammo ds co	1	1					4.0	7.0
9-86G Hhc ammo bn ds/gs	1	1					4.0	2.6
9-227G Ord gm gs co	1	2					8.0	8.4
10-407G Qm air del co	2						0	2.0
11-86E Hhc sig cbt area	1	1					4.0	3.6
11-87E Sig cbt area co	4						0	4.5
11-147E Sig sm hq op co	1		1				6.5	3.2
12-17G Spec service co	1						0	1.0
12-57G Replacement co	1						0	0.7
12-67G Personnel serv co	1						0	1.9
12-510G Data proc unit	1						0	4.0
12-605G Army postal unit	1						0	1.0
19-56G Hhd mp bn	1						0	1.5
19-57G Mp co	2						0	4.8
20-17E Mil hist det	1						0	4.8
29-102F Hhc gen sup gp	1						0	0.1
29-114G Fld svc gs co fwd	1						0	3.7
29-118G Gen sup supt co	2						0	5.9
29-119G Rep parts gs co	2						0	6.8
29-126G Hhc sup gs bn	2						0	7.1
29-127G Hvy mtl gs co	2	2					8.0	5.2
29-136G Hhd maint gs co	3						0	1.6
29-137G Hvy eq gs maint co	3	1					4.0	7.7
29-139F Cal class sal co	1	1					4.0	5.6
29-134G Lt eq gs maint co	1	1					4.0	7.1
29-206F Hq mn supt co	2		1				6.5	7.9
29-207F Lt maint ds co	2	1					4.0	5.5
32-57F ASA spt co div	2	1					4.0	6.0
44-12E Hhb ADA gp	1						0	2.0
44-235G Hawk bn	3		10				65.0	15.0
54-22T Hhc spt bde	1						4.0	7.0
55-19E Trans car co	1						0	3.4
55-28G Trans hvy trk co	1	3					12.0	*
55-67G Trans lt-med trk co	4	3					12.0	*
55-457G Tr acft ds st co	2	2					8.0	6.8
55-468G Tr acft maint co	1	2					8.0	7.5
Totals (not including line haul organizations)		58	128	20	16	40	1892 ton	1337.8
	Grand Total	262						

RAC

SIMULATION OF POOLED TANKER FLEETS

Introduction

The simulation runs necessary to estimate the performance of the two alternate pooled tanker fleets described in the previous section are very similar to the simulation runs made to determine pooled cargo fleet performance except that only one class of resupply is involved rather than two. The basic simulation run of 15 days, 7 with a FEBA advance of 10 km and 8 with an advance rate of 20 km is used and the frequency of unit moves for the units in the 14th Support Group area remains the same. Although unit moves are made to follow the scenario action, there are no unit move payloads since reserve bulk is carried by tankers remaining organic to user units. The differences in simulation inputs are of course, the vehicle fleets used, vehicle characteristics, mission payloads and load/unload capacities of the vehicle pool and of the supplied unit.

Pooled Tanker Vehicle Fleets

The two alternative pooled tanker vehicle fleets are shown in Table 4-2 while the vehicle characteristics are given in Table 4-3. Alternative one, the current fleet, consists of the vehicles organic to the petroleum supply company and supply and service company located in the 14th Support Group. The augmented pooled fleet comprises the current fleet plus tankers removed from consuming units with two or more tankers and which had assigned drivers for the vehicles pooled. The rule used was to remove all tankers from the units described for which there were full time drivers assigned. This rule was based on the assumption that tanker vehicles without full time driving were used almost exclusively as mobile storage tanks and must remain with the fuel consuming units. The exceptions to this rule were that no vehicles were removed from aviation units due to the high level of mobile filling station activity necessary in these units, and that only 5 of the 10 tankers were pooled from each of the Hawk Bns even though 9 assigned drivers per unit are available. No tankers or drivers were removed from the line haul transportation units. The augmented pooled fleet which resulted was 45 percent of the total tanker assets in the corps support group area and represents the upper limit of tanker pooling because of the constraints outlined.

Table 4-2

ALTERNATIVE POOLED TANKER VEHICLE FLEETS

Vehicle and trailer type	No. in current pooled fleet[1]	No. in augmented pooled fleet[2]
$2\frac{1}{2}$ ton tanker (M49) or $2\frac{1}{2}$ ton cargo truck (M105)[3]	9	21
$2\frac{1}{2}$ ton tanker (M49) or $2\frac{1}{2}$ ton cargo truck (M35) plus $1\frac{1}{2}$ ton cargo trailer (M105)[3]	18	37
5 ton cargo truck (M54)	0	10
5 ton cargo truck (M54) plus $1\frac{1}{2}$ ton cargo trailer (M105)	0	11
10 ton tractor (M123) plus 12 ton (5000 gal.) semi-trailer (M121)	40	40
Total vehicle/trailer combinations	67 (25.5% of total)	119 (45.4% of total)
Total tonnage capacity	753	1062
Number of assigned drivers	67	119

1. Current pooled fleet consists of vehicles organic to the petroleum supply company and supply and service company included in the units of the 19th Corps Support Group.

2. Augmented fleets comprises the current fleet plus tanker pooled from other units as explained on page 4-4.

3. All cargo trucks and trailers listed are equipped with fuel tank and pump units.

Table 4-3

TANKER VEHICLE CHARACTERISTICS

Model designator	Payload class	Payload-tons (on-road ave.)	Cost (12 yr life cycle)[1]	Maintenance factors: Scheduled MH/OH[2]	Maintenance factors: Unscheduled MH/OH[2]
M49	$2\frac{1}{2}$ ton tanker	4.0	$45,050	.067	.080
M49/M105	$2\frac{1}{2}$ ton tanker + $1\frac{1}{2}$ ton tlr[3]	6.5	49,128	.078	.091
M35	$2\frac{1}{2}$ ton cargo[3]	4.0	40,302	.067	.080
M35/M105	$2\frac{1}{2}$ ton cargo + $1\frac{1}{2}$ ton tlr	6-5	44,639	.078	.091
M54	5 ton cargo	5.0	57,938	.074	.094
M54/M105	5 ton cargo + $1\frac{1}{2}$ ton tlr	8.0	62,275	.085	.105
M123/M131A5	5000 gal. tanker	15.0	136,936	.087	.109

1. Excluding driver costs.
2. Down hours/operating hour; derivation of this data is contained in ref. 7, App. E.
3. All cargo vehicles and trailers are equipped with tank and pump units.

Mission Payloads and Load/Unload Capacities

Bulk fuel mission payloads for the two combat postures simulated are those derived from the LOGALOC II Study and the Armed Forces planning Guide - Europe in a manner similar to cargo payloads in the previous chapter. A complete listing of daily bulk fuel mission payloads to each unit is found in App. C, Tables C-5 and C-6. Figure 4-1 shows the payload spectrum in histogram form for one day's missions during the attack posture. Load/unload capacities for bulk fuel missions are based on the fuel dispensing capabilities of the petroleum supply company for loading of tankers and the pump capacities of the tanker vehicles for unloading. Inputs to the simulation for loading of the tankers at the petroleum supply company are the 6 loading points available to this company, each of which can dispense fuel into tankers at a rate of 350 gallons per minute or 1.05 ton/minute. Unloading rates for missions are based on the number of tankers in the mission, each dispensing 60 gallons per minute (0.18 tons) into receiving tankers or storage tanks at the using unit. In addition to the time allocated for load and unload of fuel, an arbitrary 20 minutes is included in each mission time for draining, emptying, and flushing tankers at the end of each mission. This drain, empty, flush routine is necessary in most cases since any returning tanker may be required to carry a fuel of different characteristics (MoGas, AvGas, or JP) on the next mission assigned.

Simulation Results

Using the inputs just described the performance of the two alternative pooled tanker fleets was simulated. The results of these simulation runs in terms of mission dispatch delays and mission completion times are shown in Figs. 4-2 and 4-3. Mission completion time for bulk fuel resupply missions is defined as time from mission request through unloading of the fuel cargo. This time includes delay in dispatch, load time, travel time to the receiving unit, unload time, and on return to the pool location the time for drain/empty/flush of the vehicle. Return travel time to the pool is not included since from the standpoint of the user unit, the resupply mission is complete on delivery and unloading of the requested fuel.

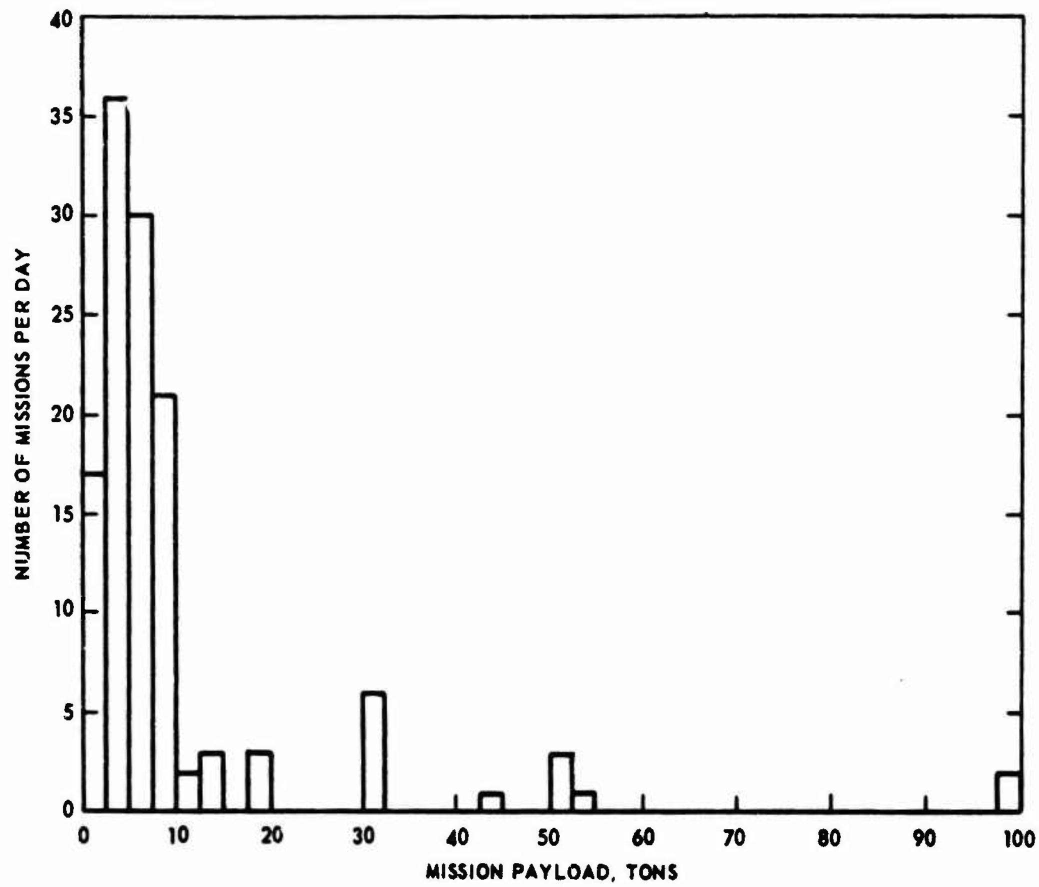


Fig. 4-1—Bulk Fuel Mission Payload Spectrum—Attack Day

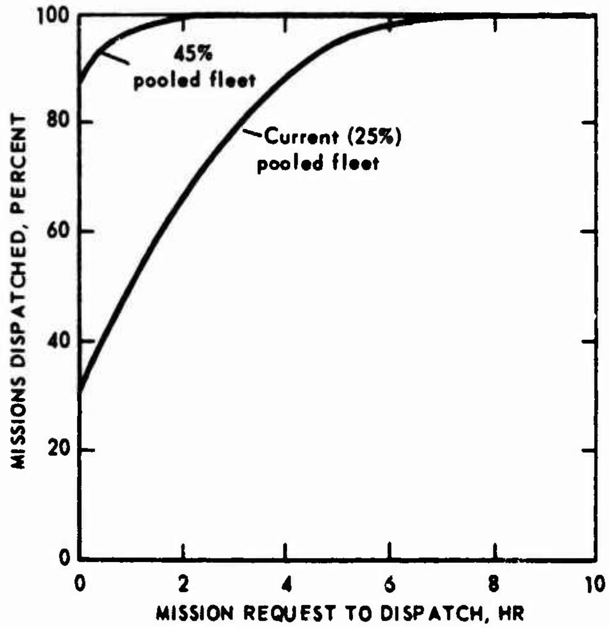


Fig. 4-2—Cumulative Mission Dispatch Times—Bulk Fuel Missions

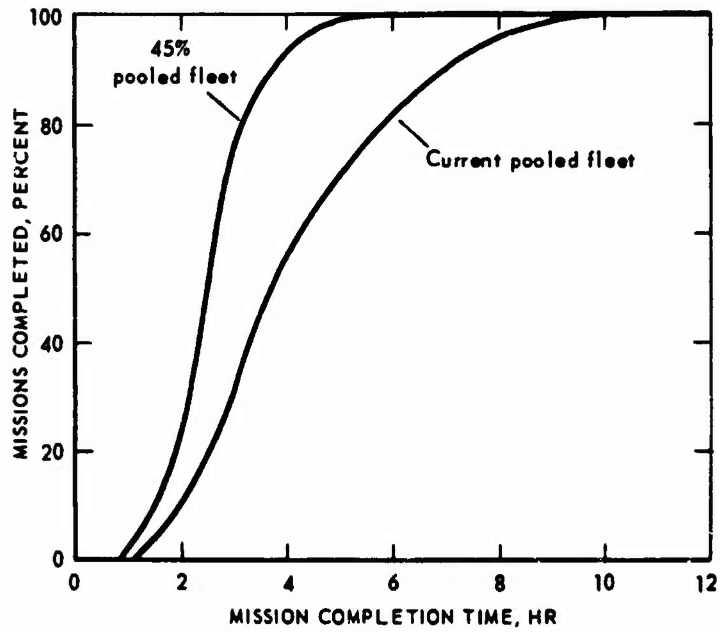


Fig. 4-3—Cumulative Mission Completion Times—Bulk Fuel Resupply

The results for the current pooled (25%) tanker fleet shown in the two figures indicate that while a high percentage of missions are delayed in dispatch, the delay times are relatively short (almost 90% of all missions dispatched within 4 hours of request). Mission completion times are fairly responsive with over 95 percent of all missions completed within 9 hours. With the augmented (45%) fleet alternative almost no mission dispatch delays are experienced and the mission completion time distribution approaches the minimum limits imposed by the distributions of travel and load/unload times for the various missions to user units.

Potential Vehicle and Driver Cost Savings

Since definitive tanker fleet performance specifications are not available, analysis of potential fleet reductions on the basis of simulated fleet performance are, of course, strictly hypothetical in nature. If it can be assumed, however, that the performance of the current pooled fleet as shown in Figs. 4-2 and 4-3 is acceptable then it is useful to provide an example of the potential tanker vehicle and driver savings represented by the difference between the current pooled fleet and the alternative augmented fleet. These potential savings are based on the assumption that the current pooled fleet performance is adequate and that the additional tankers pooled to make the 45 percent alternative would be eliminated. Table 4-4 shows the savings involved which could be as great as 8 million dollars over a 12-year life-cycle period.

More important than the specific results presented however, is the illustration of the ease of applying the fleet performance simulation developed in this and preceding studies. When fleet performance can be specified and simulation inputs validated, a tested method is available to produce rapid comparisons of conceptualized alternative vehicle fleets. These alternative fleets might include the substitution of collapsible fabric drums for some of the tankers now used primarily for bulk fuel storage. Another possible alternative for future analysis is the pooling of tanker vehicles from tanker/trailer combinations while leaving the trailer mounted tank and pump units with using units. These trailers could then serve as both storage tanks and mobile fillings stations if they were towed by another prime mover from the unit.

Table 4-4

POTENTIAL TANKER VEHICLE AND DRIVER SAVINGS

Vehicles added to current fleet to form augmented fleet: Type	No.	Vehicle costs ($k)
$2\frac{1}{2}$ ton tanker	12	540.6
$2\frac{1}{2}$ ton tanker + tlr	19	933.432
5 ton tanker	10	579.38
5 ton tanker + tlr	11	685.02
Totals	52	2,738.4
Assigned Drivers: No. & Cost	52	5,366.4
Total Cost		8,104.8

Chapter 5

MAINTENANCE SERVICE SUPPORT

INTRODUCTION

The maintenance support elements of the support group assist user units in keeping equipment in a serviceable condition and to repair and return unserviceable equipment. The maintenance activity includes organizational, direct support, and general support provided for equipment of the support group units and in addition, overflow direct support and general support provided for divisional equipment.

The vehicle assets used for maintenance support are contained in the classes that perform retrieval and service support tasks (REVAL WHEELS Tasks 3.4 and 3.5[1]). Preliminary analysis indicated the possibility that a significant number of the vehicles could be used to perform a task for several units or could be used for cross-task purposes. Such vehicles are considered eligible for pooling. In contrast, vehicles that are equipped to perform only a single task for a single unit or to perform a task on a continuous basis are not eligible for pooling.

ORGANIZATION

The organization of the field army maintenance support is composed of many specialized companies which are listed in Table 5-1. With the exception of two units, the corps support group contains all of the maintenance elements found in the army service area.

The number and location of each unit type is dependent on the tailoring for support. Individual company sized elements and their location in the typical corps support area are shown in Fig. 5-1.

Table 5-1

FIELD ARMY MAINTENANCE SUPPORT

TOE	Unit	Support
9-017	Ord ammo DS/GS co	Ammunition DS/GS
9-047	Ord sp ammo DS co	Sp. ammunition DS
9-087	Ord sp. ammo GS co	Sp. ammunition GS (in army svc. area)
9-117	Tire repair co	Tires GS (in army svc. area)
9-227	Ord GM GS co	Large missile GS
9-247	Ord GM DS co	Large missile DS
29-102	GS group hq co	Crypto logistics DS/GS
29-114	Field service co	Clothing GS, salvage point
29-119	Repair parts co	Parts GS - automotive, aircraft, avionics, chemical, engineer, artillery, small missile, POL, communications-electronics, laundry, food
29-134	Lt eq. maint. co	Repair GS - chemical, engineer, food, C-E
29-137	Hvy eq. maint. co	Repair GS - auto, laundry, POL, arty, small missile
29-139	Collect & class co	Salvage point
29-206	Hq & main. support co	Parts & repair DS — All except aircraft, avionics, clothing, air deliv., missile, ammo, crypto
29-207	Lt. maint. co	Parts & repair DS — All except aircraft, avionics, clothing, air deliv., missile, ammo, crypto
29-217	Supply & svc co	Clothing DS
55-457	Trans acft DS co	Aircraft & avionics DS
55-458	Trans acft GS co	Aircraft & avionics GS

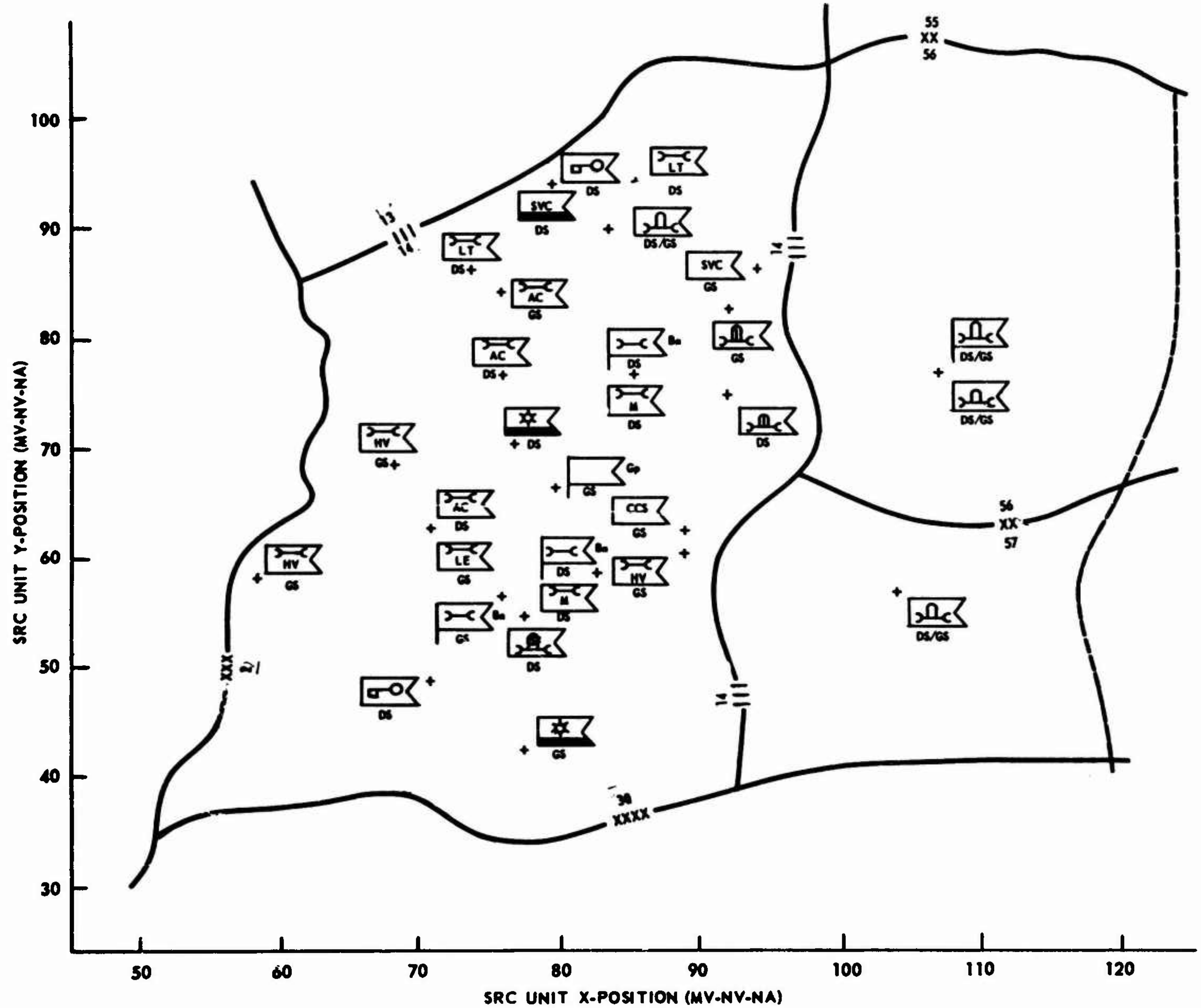


Fig. 5-1—Maintenance Support Organization—14th Support Group

OPERATIONS

Maintenance service support is accomplished by performing the following functions:

a. Parts — Maintenance units secure, store, and issue a supply of mission-essential and fast moving repair parts for maintenance operations and supported units. The supply flow is shown in Fig. 5-2. The supporting GS repair parts companies supply parts directly to DS or GS units. DS units normally serve as the source of supply to used units. Most maintenance units also stock an operational readiness float of critical equipment.

b. Recovery and Evacuation — Maintenance units set up collection points throughout the area to receive, segregate, and dispose of recovered equipment. Materiel to be scrapped is turned over to a salvage point. The flow of materiel is shown in Fig. 5-3. The primary responsibility for recovery to a collecting point or maintenance unit rests with the using unit. The maintenance unit provides evacuation of the recovered equipment to a higher category of maintenance or to the salvage point.

c. Repair Shop — DS maintenance units provide support on a repair and return-to-user basis. GS units repair and then return repaired items to the supply channels. The repair facilities that operate in a maintenance unit are described as a "maintenance shop." This shop consists of sections to perform functions of control, classification, repair, and evaluation. Organization for repair support is shown in Table 5-2. Centralized shop work is emphasized for efficiency of maintenance work.

d. Contact Maintenance — On-site maintenance is performed in the field or at user units when items to be repaired are not easily removed or when on-site performance speeds up critical service.

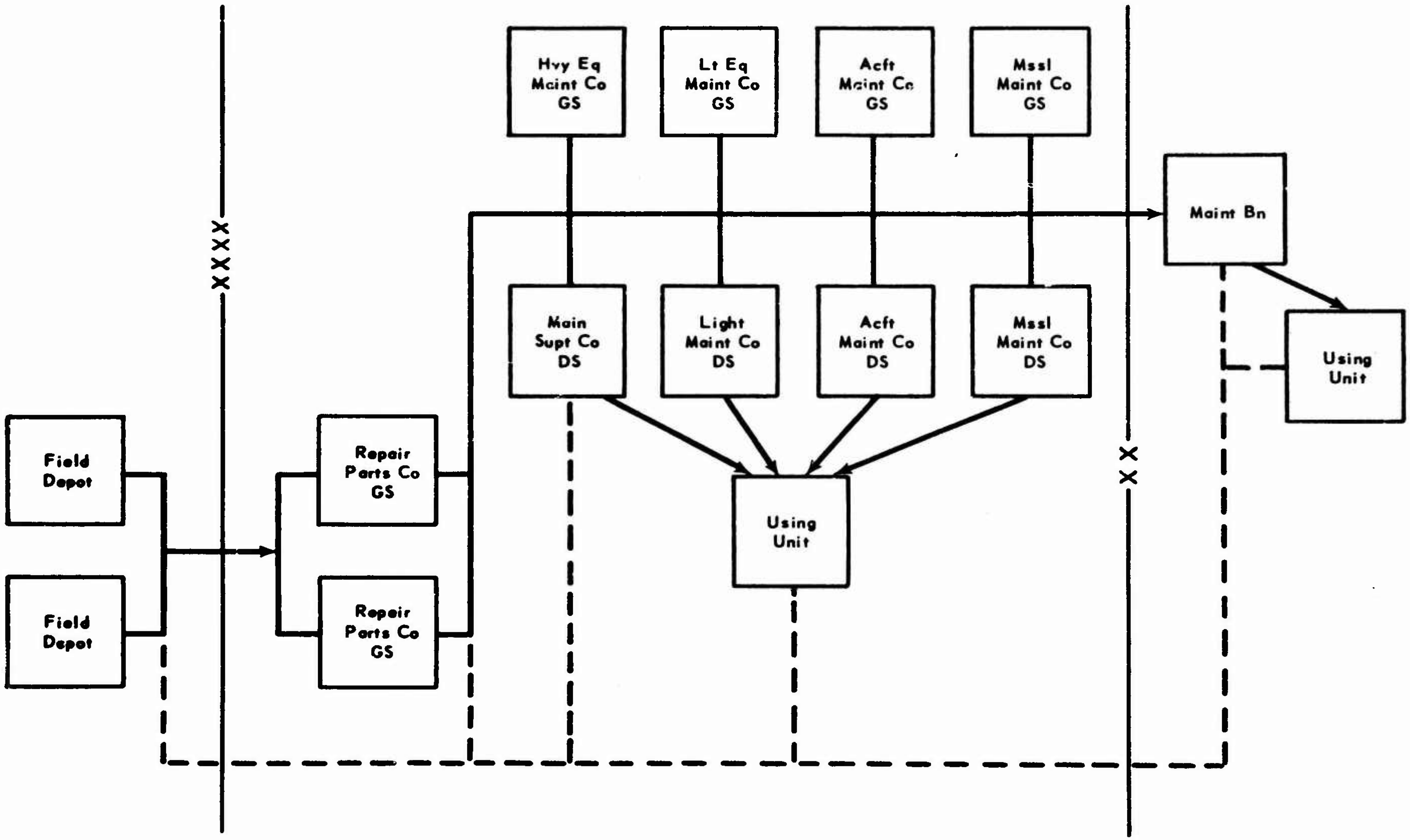


Fig. 5-2—Delivery of Repair Parts

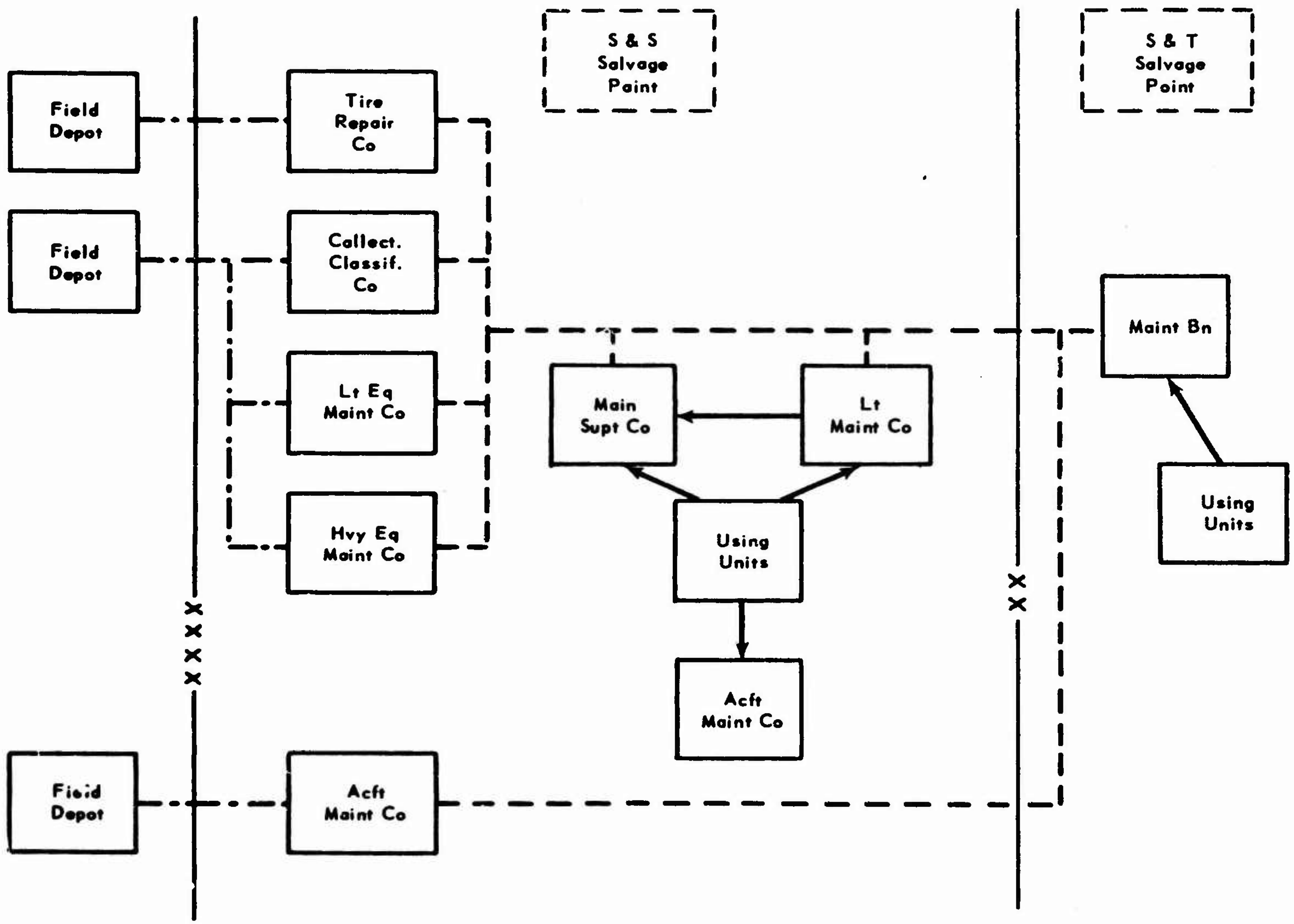


Fig. 5-3—Evacuation of Unserviceable Equipment

Table 5-2

MAINTENANCE SERVICE SUPPORT

Category	Direct support	General support	
		Parts	Repair
Automotive, construction, materials handling, laundry, artillery, small arms, fire control	29-206 Main supt co or 29-207 Lt. maint co	29-119 Repair parts co	29-137 Hvy. eq. maint co
Small missile	Organic	29-119	29-137
Smoke/flame/decontamination, survey, power, refrigeration, heating, communication, photographic, infrared	29-206 or 29-207	29-119	29-134 Lt. eq. maint co
Data processing	Organic	29-119	29-134
Tires	29-206 or 29-207	29-119	9-117 Tire rep co
Aircraft, avionics	55-457 Trans. acft DS co	29-119	55-458 Trans. acft GS co
Large missile	9-247 Ord GM DS co	9-227 Ord GM GS co	
Clothing, textiles	29-217 Supply & serv co	29-114 Field service co	
Special ammunition	9-47 Sp. ammo DS co	9-87 Sp. ammo GS co	
Ammunition	9-17 Ord ammo DS/GS co		
Cryptographic	29-102 GS group headquarters co		
Air delivery	10-407 QM air delivery co		

Contact teams attempt to ascertain and carry with them the parts required to perform the repair.

e. Technical Assistance — This is the service of providing advice, assistance and training to supported units pertaining to maintenance and maintenance supply. Supported units request such service when they are unable to cope with a problem. Liaison parties also visit units on a regular basis.

The operations just described provide the basis for the justification of the maintenance and evacuation vehicles assigned to maintenance elements. User units or maintenance units request these services. These requests define a set of missions to be performed with the maintenance support vehicles. The analysis of vehicle fleet response in support of the performance of the missions provides quantitative support for vehicle justification.

VEHICLE ASSETS

The evacuation and maintenance vehicles are identified by REVAL WHEELS Tasks 3.5 and 3.5 and specified by TOE paragraph. Table 5-3 shows the total of 3.4 and 3.5 vehicles in the 14th Support Group structure. Included in the 3.5 vehicle category are vehicles that perform personnel and medical services. These latter vehicles are not included in the maintenance vehicle analysis. A methodology for simulation of ambulance operations was presented in the previous RAC study[7].

In addition to a count of vehicles, it was necessary to classify the 3.5 vehicles in relation to the operations categories previously discussed. For the maintenance shop operation, the shop sets and tool kits are assets that must be available for shop service. For this analysis, vehicles authorized to carry shop sets and the heavy tool kits are considered as self-propelled shop equipment rather than vehicles that respond to transport demands. It is assumed that the shop operations remain in their current organizations. Another operational class of vehicles provides parts storage facilities. The majority of this class are supply van semi trailers. These parts supply vehicles are assumed to remain with the shop operation in their current organizational

Table 5-3

SERVICE SUPPORT VEHICLES
IN 14TH SUPPORT GROUP

Maintenance services		
Organizational	687	
Direct support	443	
General support	361	
		1491
Personnel services		55
Medical services		
Ambulance	120	
Equipment	108	
		228
		1774

unit. The shop and parts storage vehicles are candidates for containerization in the manner described in Chapter 6. In fact, a portion of the supply semi-trailers are operated in company level containerization pools with the ratio of one tractor to two semi-trailers.

The operations in which maintenance service pooling may be considered are repair parts delivery, contact maintenance/technical assistance, and recovery/evacuation.

The classification of vehicle assets and operational category within Task 3.5 was developed from consideration of individual company level TOEs and AR 310-34 which establishes vehicle authorization for the heavy shop sets and tool kits. The maintenance and recovery vehicle categorization is shown in Table 5-4.

ALTERNATIVE VEHICLE EMPLOYMENT

Current Fleet

In the current organization of maintenance vehicles, user units have vehicles for organizational maintenance, and in a few cases, vehicles for direct support maintenance. The supporting maintenance units have vehicles for DS and GS maintenance, and also vehicles for their own organizational maintenance.

The maintenance vehicles are thus distributed among almost all of the units in the support group. Whenever a unit has a period of high demand for maintenance services, the relatively few vehicles are heavily used and long delays may occur.

Support Group Pool

An alternative employment of vehicles is service area pooling where the maximum practical pool of maintenance vehicles is formed under centralized control in the corps support area. Vehicles which are authorized for shop sets or are used for parts storage are not included in the pooled operation. These vehicles are central to the maintenance shop activity at each company. The vehicles that are assumed to be pooled are those which provide transportation service for the functions of repair parts delivery, contact maintenance/technical assistance, and recovery/evacuation.

The eligible vehicles of the current fleet and the parametric

Table 5-4

MAINTENANCE VEHICLE DISTRIBUTION
IN 14TH SUPPORT GROUP

Maintenance category	Vehicle task category				
	Shop	Parts stor.	Parts deliv.	Contact	Evacuation
Organizational	415	14	14	137	107
Direct support	172	77	39	120	35
General support	127	83	35	70	46
	714	174	88	327	188

pooled fleet sizes are shown in Table 5-5. Approximately 40% of the maintenance service vehicles are included in the current fleet/100% pool.

Two pooled alternatives are proposed to consider different extents of pooling. In the first, it is assumed that the pool is only for transport purposes. In each mission requiring parts or specialists the vehicle must go via the requesting unit. This requires a relatively long travel distance. In the second, it is assumed that the associated parts and specialists are also pooled. The vehicle may then travel directly to the job. This requires a travel distance shorter than the other pool alternative but longer than the current fleet travel distance.

DEMAND FOR VEHICLE SERVICES

A current Combat Developments Command study "Family of Army Vehicles—1985"[10] was consulted to obtain time frequency data on maintenance missions. The form of the data available was unit daily frequency totals for each type of vehicle mission. In the original working papers the frequencies were assessed for the individual, specific TOEs. In the available summary, the mission/frequency data was aggregated by TOE series type. A sample of maintenance service missions is shown in Table 5-6. These missions were extracted from the approximately 1250 entries that describe all tactical vehicle tasks in the FAVS summary.

Individual missions were then reassociated with specific units based on judgment of the unit's organizational capabilities and equipment. The mission input for an example GS maintenance unit is shown in Table 5-7.

Based on the discrete payload and mission function the order of vehicle preference was determined by inspection of the available vehicles. Vehicles of closest higher payload capacities are used first. For parts delivery only, multiple vehicles of smaller payload were used with lower priorities. No loads exceed the rated capacities.

For the pooled case, the mission requests were combined for all the companies with maintenance activity.

Table 5-5

VEHICLE ASSETS - MAINTENANCE POOL

Size of Pooled Fleet

Vehicle type	100%	80%	60%	40%
1. 3/4T truck	19	15	11	8
2. 3/4T truck + 3/4T trailer	113	90	68	45
3. 2½T truck	39	31	23	15
4. 2½T truck van expansible	1	1	1	0
5. Shop equip. contact maint. truck mounted	35	28	21	14
6. 2½T truck + 1½T trailer	162	129	97	65
7. 2½T truck van shop + 2½T trailer generator	5	4	3	2
8. 2½T truck wrecker	5	4	3	2
9. 5T truck tractor + 12T semi-trailer stake	47	38	28	19
10. 5T truck wrecker	128	102	77	51
11. 5T truck tractor + 12T semi-trailer wrecker	5	4	3	2
12. 10T truck tractor + 50T semi-trailer transport	12	10	7	5
13. Personnel carrier	12	10	7	5
14. Recovery vehicle, tracked	20	16	12	8
	603	482	361	241

Table 5-6

MAINTENANCE SERVICE MISSIONS

Family of Army Vehicles Data Summary

TOE series	Unit type	Typical daily missions for company-size units					
		Cont. maint., tech. asst.		Recovery, evacuation		Repair parts delivery	
		Weight	Freq.	Weight	Freq.	Weight	Freq.
1	Aviation	350	1	TOW	3	750	1
3	Chemical	1,500	6	-	-	2,500	4
5	Engineer	1,500	20	TOW	12	12,000	1
6	Artillery	4,000	4	TOW	6	10,000	2
8	Medical	2,500	6	-	-	-	-
9, 29, 55	Maintenance	2,000	4	TOW	12	12,000	2
9, 10, 29	Supply & svc.	1,500	12	100,000	4	24,000	2
11	Commo-elec.	1,500	12	TOW	2	6,000	2
12	Pers & admin	1,500	6	-	-	8,000	1
17	Armor	4,000	4	TOW	3	6,000	4
19	Mil Police	1,500	1	TOW	1	5,000	1
32	Sec. agency	4,000	2	TOW	5	4,000	2
44	Air defen.	4,000	4	TOW	3	10,000	2
55	Transport.	2,500	12	100,000	2	20,000	2

Table 5-7

MAINTENANCE SERVICE MISSIONS

2109 Heavy Equip. GS Maint. Co. - Coord. MV8856

Activity	Function	Weight lb.	Radius km	Frequency daily
General	Parts delivery	12,000	15	2
General	Parts delivery	6,000	15	6
General	Evacuation	100,000	20	4
General	Evacuation	Tow	20	12
Quartermaster	Contact	2,500	15	4
Artillery	Contact	2,500	25	2
Fire control	Contact	2,500	25	2
Engineer	Contact	2,000	20	8
Chemical	Contact	1,500	15	6
Automotive	Parts delivery	5,000	15	3

SIMULATION OF FLEET OPERATIONS

The analysis of fleet operations is performed with the stochastic simulation program described in Chapter 2. For each case, the problem is to examine the response of a mixed vehicle fleet to a mixed set of mission demands.

Vehicle Characteristics

The vehicles, by type, were presented in a preceding section. The rated vehicle combination payload was used for carried loads to determine if a vehicle was capable of lifting the mission load. For wrecker missions, it was assumed that a wrecker at least as big as the current fleet wrecker is required for all a unit's recovery missions.

The missions are specified in terms of a radius distance measure and must be converted to a time basis. It was assumed that travel would occur on the well developed road net at an average travel speed of 40 kmph for the wheeled vehicles. For the tracked vehicles a speed of 20 kmph was assumed. A road network factor of 1.6 was used to convert straight line distance to road distance.

As each vehicle returns from a mission assignment, a 25-minute period is counted as driver maintenance, the cumulative operating time is checked to determine if scheduled maintenance is due, and a random number is used to determine the occurrence of unscheduled maintenance. The parameters of this maintenance phase were set to produce approximately 25% maintenance time under heavy utilization. This is felt to be reasonable for the corps/army service area vehicles.

A typical time utilization profile is shown in Fig. 5-4 for a parameter reduction in a pooled fleet. The absolute value of load/unload and travel time is determined by the set of missions to be accomplished. As the number of vehicles is reduced the utilization per vehicle must increase accordingly. When idle time has been reduced to zero, there can be no additional increase in vehicle use and long dispatch delay may be introduced.

Missions

The mission frequencies appear to represent the peak expected demand for maintenance services. Each result is for eight consecutive days at the peak demand. A two shift, 20-hour day was assumed for all vehicle operations.

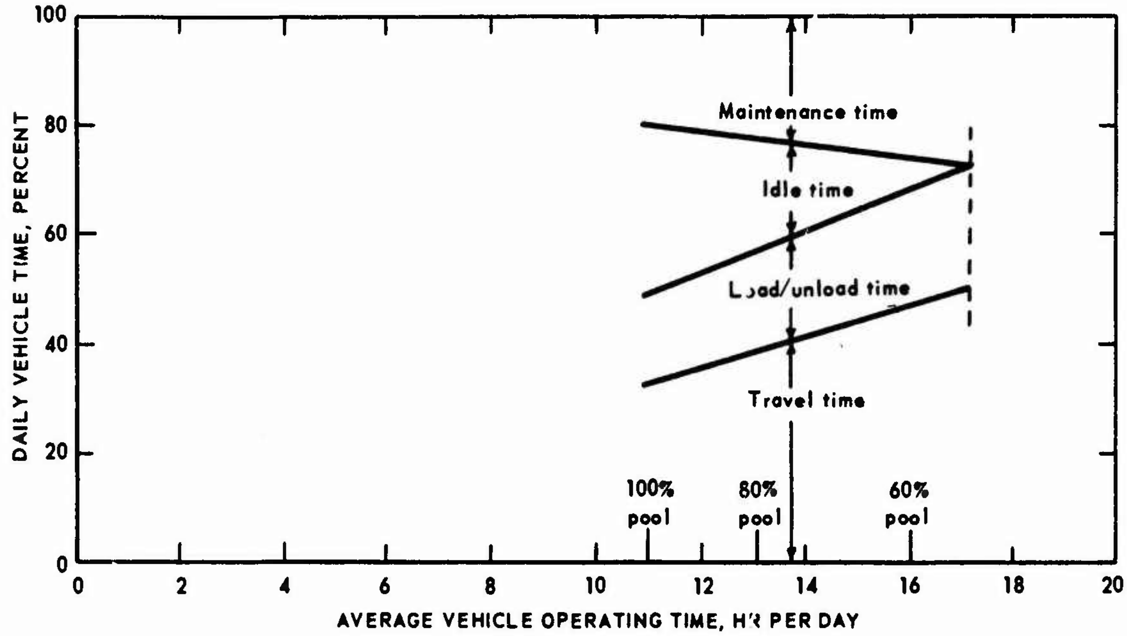


Fig. 5-4—Vehicle Time Utilization Profile—Contact, Parts, and Recovery Pool

For the parts delivery missions, load and unload rates were set so that the total load and unload time would not generally exceed one hour. For contact maintenance, a constant 60-minutes is added to the turnaround time for each mission to represent the accomplishment of the maintenance. For recovery missions, a 45-minute period is added to represent time involved in the vehicle recovery.

For the current fleet results, return travel time is included in mission completion time for recovery missions but is not included for parts delivery and contact maintenance. For pooled recovery missions the wreckers go from the pool to the location of the objective equipment and then take it to the location of the requesting unit. The return travel to the pool is not included in mission completion time.

Pooling alternative A indicates the case where the maintenance vehicle must travel via the requesting unit to pick up parts or specialists. In alternative B the vehicles proceed directly from the pool to the desired location and back. Return travel is not included in mission completion time for parts and contact missions in either alternative.

SIMULATION RESULTS

The mission inputs represent a fixed level of effectiveness to be achieved by each vehicle fleet. The comparison of different fleets and operating modes is made on the basis of dispatch delay times or mission completion times.

Results are presented first for the current operation which is considered the reference for comparison. The second set of results considers the pooling of all the corps support maintenance vehicles that were included in the current fleet case. A third set of results is presented for a pooled fleet that does not include recovery vehicles.

Current Maintenance Fleet

The current fleet results are obtained by analysis of each unit maintenance activity and the combination of these individual results to represent the total maintenance vehicle response. Each unit was treated as a company level pool, with any eligible vehicle performing any mission regardless of section assignment.

The organizational maintenance missions were found to contain the greatest mission delays. The DS and GS vehicles would normally be used

to perform the most delayed missions of organizational maintenance. The current fleet results were modified by switching mission requests from the most delayed units to DS or GS units that had least delays.

The cumulative dispatch delay times for these modified current fleet results are shown in Fig. 5-5 by mission function category and by maintenance category type. The total organizational maintenance delay is still longer than that of DS or GS maintenance. A small overall improvement could be achieved by performing more overload organizational maintenance missions with higher echelon maintenance vehicles.

A greater problem appears to be the response of the wrecker subfleet to the recovery missions. No attempt was made to exchange cargo type vehicles for wreckers, but this would be a significant change in this situation.

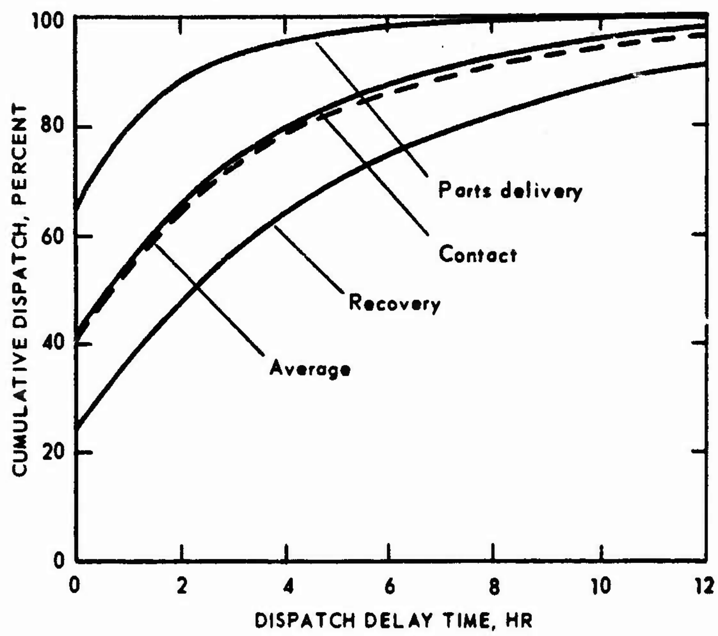
The results appear reasonable in that under peak demand conditions the vehicles, distributed in small number with many units, cannot keep up if near simultaneous requests occur and delays must occur.

The total cumulative mission completion times for the current fleet are shown in Fig 5-6. For overall response, half the missions are completed within three hours and 90% are completed within 10 hours (in the period of one shift). For the missions completed beyond 10 hours the daily completion rate per vehicle is less than two missions per day. The average request level for this peak demand is approximately four missions per day per vehicle. Therefore, if more days were added at the same mission rate, the delays would accumulate faster.

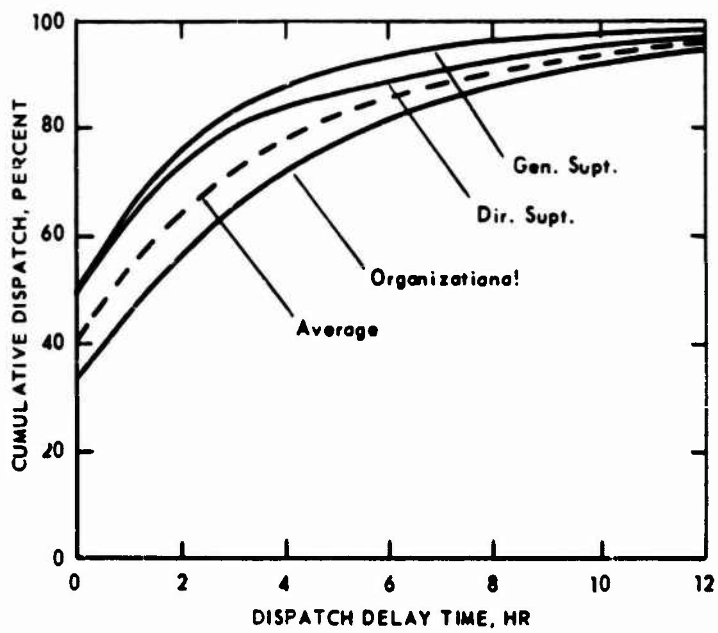
<u>Pooled Maintenance Fleet</u>

In this alternative, all the applicable maintenance vehicles are considered to be removed and placed under centralized control in the corps service area. Mission requests from user units are routed to the pool and vehicles are dispatched to support the entire support group.

<u>Complete Pool</u>. The dispatch delay time for the pooled and current fleet are shown in Fig. 5-7. Alternative B is the pooling case with direct dispatch to the mission location. The dispatch delay for this pooled case is better than for the current fleet. Seventy percent of missions are dispatched with no delay and all missions are dispatched within six hours. Alternative A is the pooling case with missions routed via



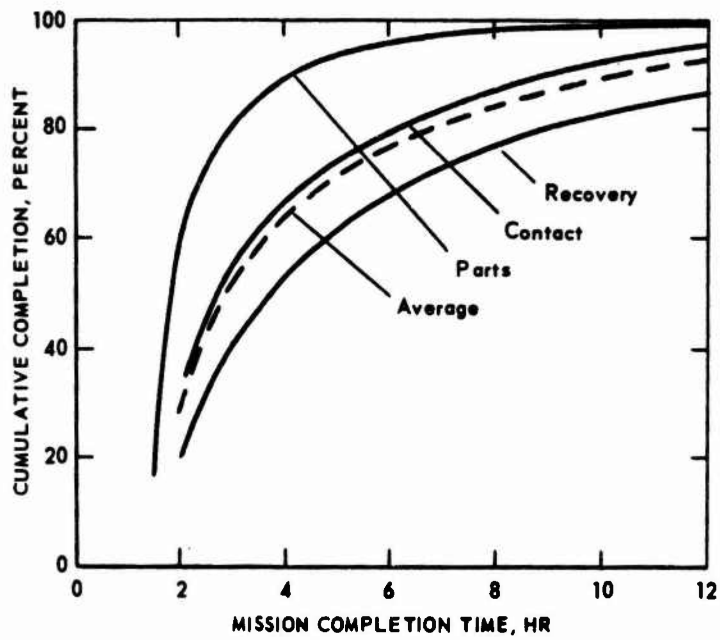
a. Mission Type



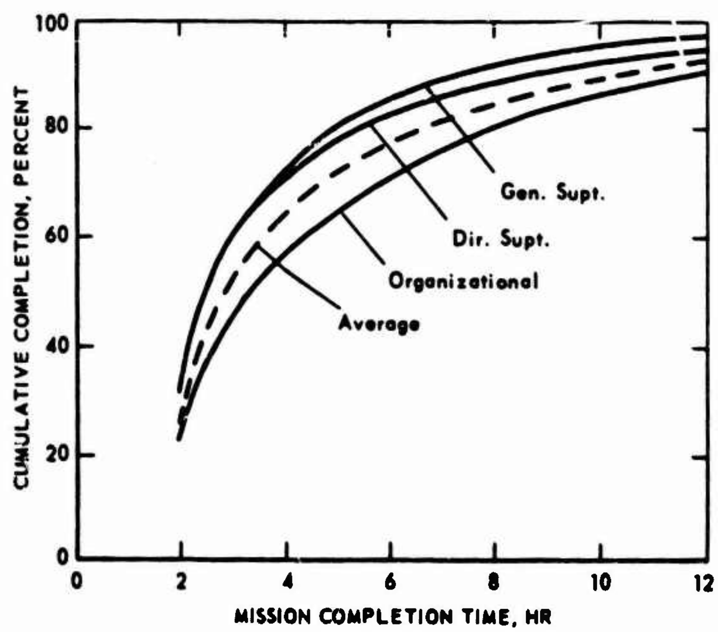
b. Maintenance Type

Fig. 5-5—Summary of Dispatch Delay Times

Modified current maintenance fleet.



a. Mission Type



b. Maintenance Type

Fig. 5-6—Summary of Completion Times

Modified current maintenance fleet.

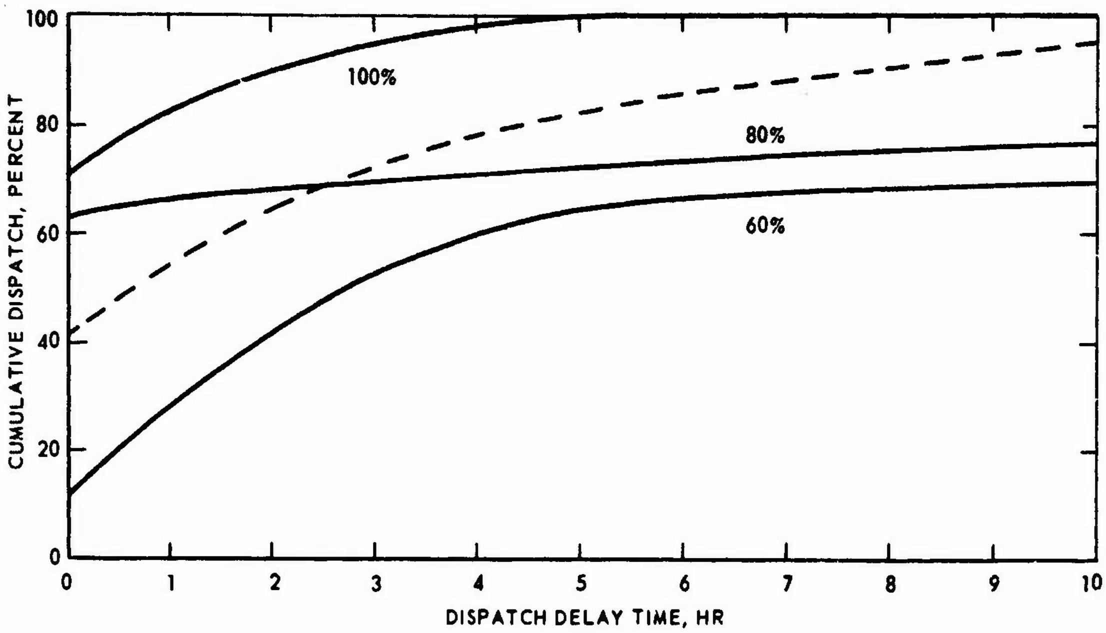


Fig. 5-7—Dispatch Delay Time—Contact, Parts Delivery, and Recovery Pool

– – – Current fleet ——— Pooled fleet, Alternative B

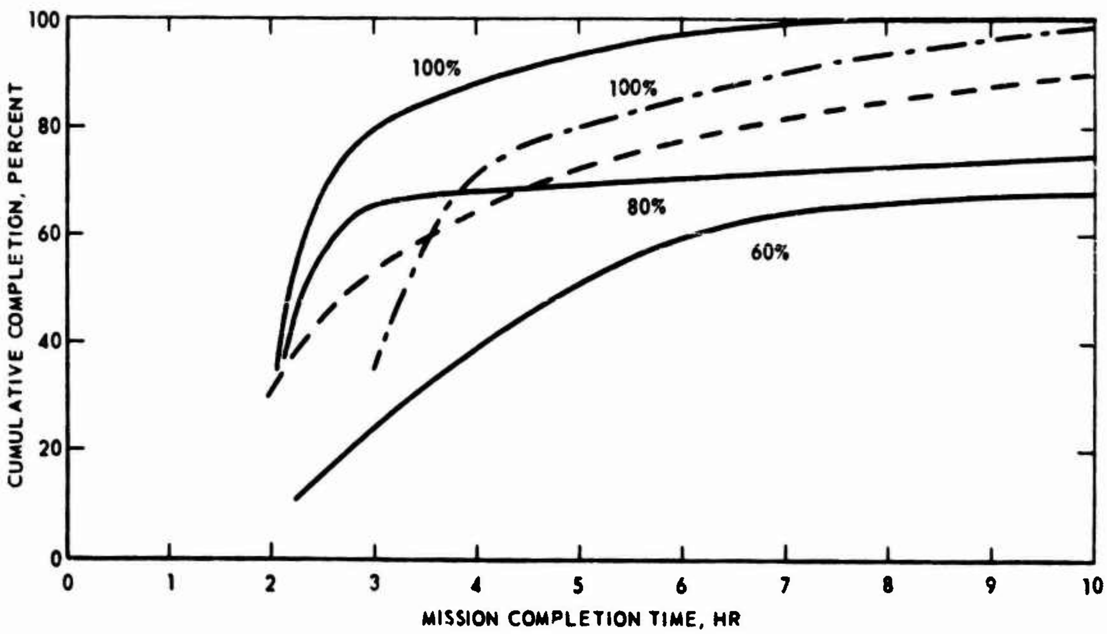


Fig. 5-8—Mission Completion Time—Contact, Parts Delivery, and Recovery Pool

– – – Current fleet Pooled fleet: —·— Alternative A ——— Alternative B

the requesting unit. In addition, 15 minutes is added to the turnaround time for the extra stop. Although not shown in Fig. 5-7 the dispatch delay time for alternative A is midway between that for alternative B and the current fleet.

The pooled maintenance fleet is also concerned with the problem of driver allocation as discussed in Chapter 3. A majority of maintenance vehicles are driven by personnel whose principal jobs are maintenance specialties. For alternative A, full-time drivers would be required and the contact maintenance mechanics would still spend the same portion of time riding in transit.

For alternative B, it is possible to consider that unit specialists who spend all their shift on the road could be part of a pooled operation provided the unit equipment receives equivalent maintenance service.

No significant reduction in vehicle strength appears possible with the pooled fleet. As soon as the number of vehicles is reduced the recovery operation undergoes large delays. This is the major impact on the shape of the 80% pooled fleet curve in Fig. 5-7. At 60% of the pooled fleet, the contact and parts delivery delays start to add to those of recovery.

The mission completion times for the pooled fleet and current fleet are shown in Fig. 5-8. The pooled fleet performance is better than that for the current fleet. Eighty percent of missions are completed in three hours and all missions are complete by nine hours. The response curve of the current fleet, however, is probably preferable to that for the 80% pooled fleet. A comparison of the alternatives with the current fleet using the single index of average mission completion time is shown in Fig. 5-9. This figure reflects the previous conclusion that the pooled alternatives promise improved mission response over the current fleet but no significant reduction can be made in vehicles for this peak demand situation. The current fleet cannot absorb any vehicle reduction without a large increase in delay times.

<u>Partial Pool</u>. Since the recovery operations are the most difficult problem in the fleet response, pooling results were determined for a combined contact maintenance and parts delivery pool. The wreckers are considered to remain organic to individual units. The eligible vehicles of the current fleet and the parametric pooled fleet sizes are shown in Table 5-8.

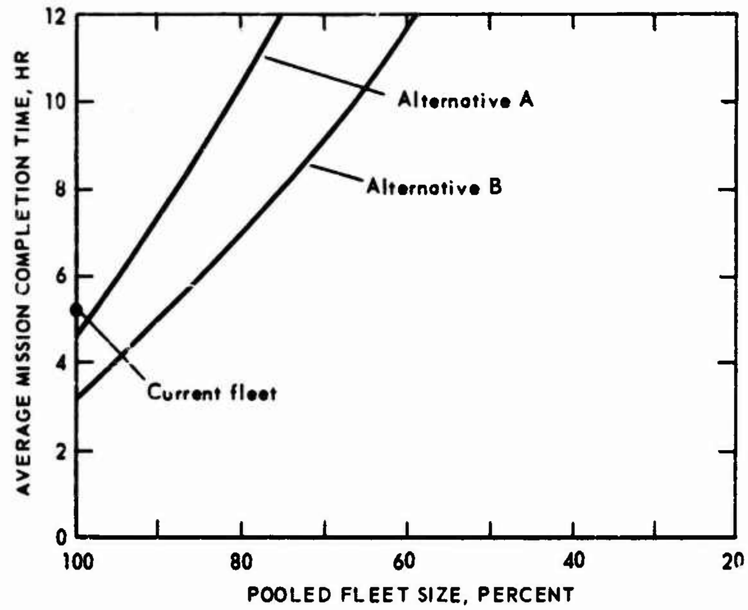


Fig. 5-9—Comparison of Average Mission Completion—Contact, Parts Delivery, and Recovery Pool

Table 5-8

VEHICLE ASSETS - PARTIAL POOL

Vehicle type	Size of Pooled Fleet			
	100%	80%	60%	50%
1. 3/4T truck	19	15	11	9
2. 3/4T truck + 3/4T trailer	113	90	68	57
3. $2\frac{1}{2}$T truck	33	27	20	16
4. $2\frac{1}{2}$T truck van expansible	1	1	1	1
5. Shop equipment contact maint. truck mounted	35	28	21	18
6. $2\frac{1}{2}$T truck + $1\frac{1}{2}$T trailer	154	123	92	77
7. $2\frac{1}{2}$T truck van shop + $2\frac{1}{2}$T trailer generator	5	4	3	2
8. 5T truck tractor + 12T semi-trailer stake	43	34	26	22
9. Personnel carrier, tracked	12	10	7	6
	415	332	249	208

The dispatch delay times are shown in Fig. 5-10 for the pool and current fleet which perform the contact and parts delivery. With a 60% size of the pooled fleet all missions are dispatched in four hours. For the current fleet all missions are not dispatched within ten hours. Similar mission completion times are shown in Fig. 5-11. The figure shows the effect on response when the maximum possible utilization is reached between 60% and 50% size of the pooled fleet. A comparison of average mission completion time is shown in Fig. 5-12. With either pooling alternative a better response time to peak demands is obtained and some vehicle reduction is possible.

A cost comparison for the contact and parts delivery operation, partial maintenance pool, is shown in Table 5-9. The total 12 year cost for the vehicles currently performing this service is $16,488,000. The fleet levels associated with pooling alternatives A and B were selected to provide the same average mission completion time as indicated in Fig. 5-12.

The REVAL WHEELS data indicates that there are 61 assigned full duty drivers for the 415 vehicles. This implies that there are 354 mechanics or parts specialists used as additional duty drivers. For Alternative A, there must be a full time driver for each vehicle. This element makes a pure transport pool for maintenance service impractical. For Alternative B, which considers the pooling of operations as well as transport, it was assumed that the 61 full duty drivers of the current fleet are assigned and the remaining vehicles are driven by additional duty drivers. The 12 year driver and vehicle cost of $18 million for Alternative B represents the least cost, and a $9 million saving from the current operation.

Also shown in Table 5-9 is an indication of driver demand for the peak wartime mission rate. The demand was determined by taking the sum of daily transit time plus load/unload time for each alternative and dividing by 10 hours per full duty driver.

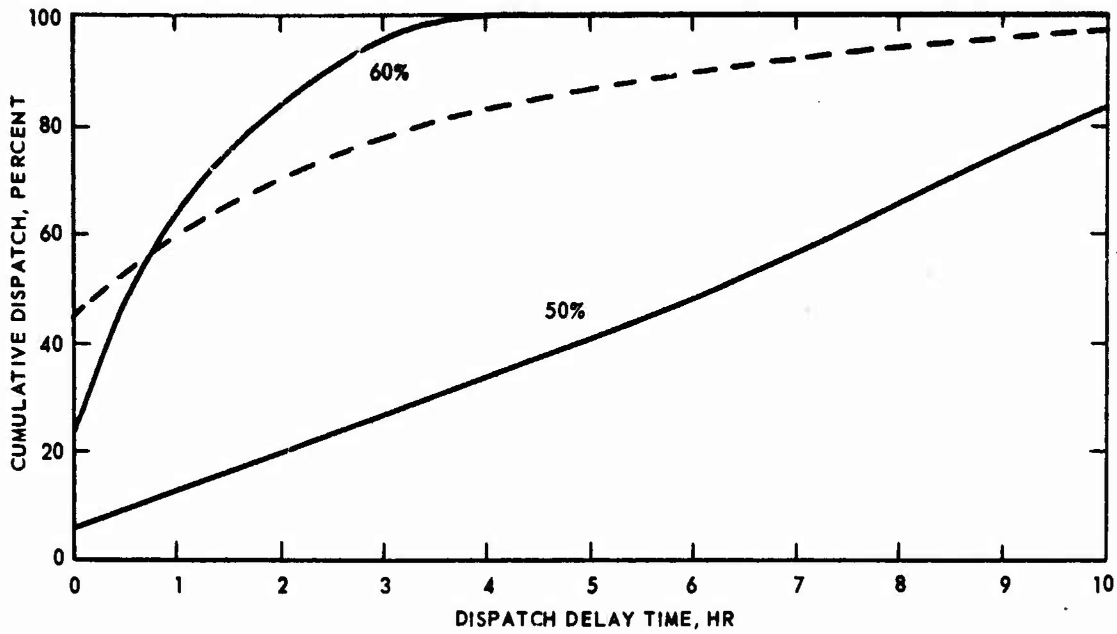


Fig. 5-10—Dispatch Delay Time—Contact and Parts Delivery Pool

— — — Current fleet ——— Pooled fleet, Alternative B

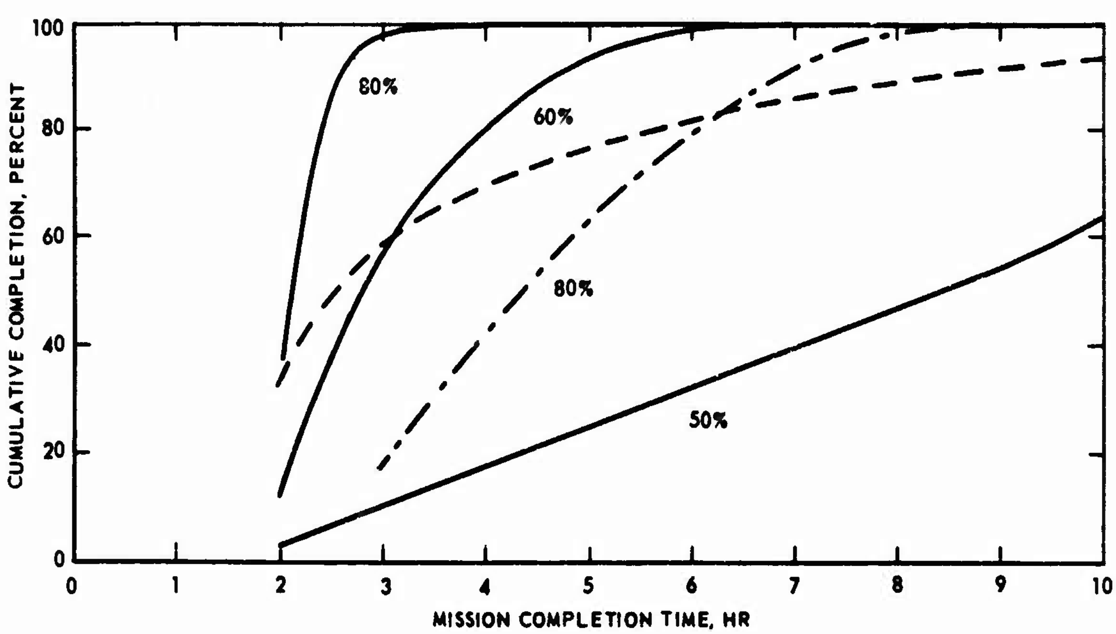


Fig. 5-11—Mission Completion Time—Contact and Parts Delivery Pool

— — — Current fleet Pooled fleet: —·— Alternative A ——— Alternative B

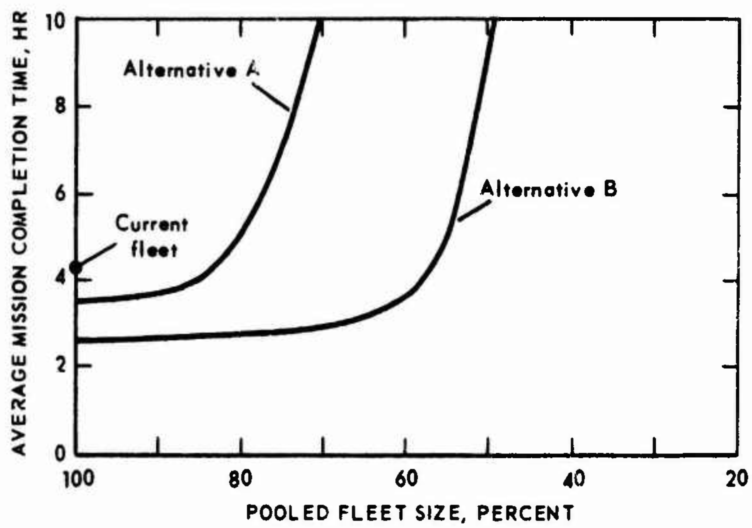


Fig. 5-12—Comparison of Average Mission Completion—Contact and Parts Recovery Pool

Table 5-9

COST COMPARISON - CONTACT AND PARTS DELIVERY OPERATIONS

Alternative	Fleet	Vehicle Cost 12 Year	Peacetime Driver Cost, 12 Yr.	Peak Demand Driver Cost, 1 Yr.	Peacetime Driver + Vehicle Cost, 12 Yr.
Current Operation	100% 415 vehicles	$16,488,000	$10,543,000 61 full duty 354 addnl. duty	$2,649,000 308 equivalent full duty	$27,000,000
Alternative A Vehicles Only	84% 350 vehicles	$13,850,000	$36,120,000 350 full duty	$4,369,000 508 equivalent full duty	$50,000,000
Alternative B Vehicles & Mechanics	57% 237 vehicles	$ 9,398,000	$ 8,407,000 61 full duty 176 addnl. duty	$3,234,000 376 equivelant full duty	$18,000,000

Chapter 6

CONTAINERIZATION

INTRODUCTION

A prime factor which inhibits the application of the concept of vehicle pooling is that many vehicles of the general cargo type carry loads which are permanently attached to the vehicle chassis. These loads such as shop vans, laboratory sets, and fire control vans are required on a continuous basis by the using unit and hence the vehicle chassis also remains stationary. The RAC study team was asked by the Army Study Advisory Group to examine the concept of containerizing these fixed loads and pooling the vehicle chassis at a centralized location. The objective is, of course, to examine the size of the pooled chassis fleet necessary to provide responsive movement of the containerized loads as a part of user unit moves and to evaluate possible vehicle savings through this form of pooling. This portion of the study in no way addresses the question of containerization of loads in general, but simply assumes that certain loads that are presently in a form easily containerized can be detached from the vehicle chassis and the chassis then pooled.

CONTAINERIZED LOADS AND VEHICLE CHASSIS

A survey of tactical vehicles organic to the units within the 14th Support Group resulted in the selection of 475 vehicles carrying fixed loads which might be containerized and the chassis then pooled. The results of this survey are shown in Table 6-1, which includes the vehicle type and load, the unit to which the vehicle is currently assigned, and the number of assigned drivers for the vehicles selected. It should be emphasized that the vehicles shown in Table 6-1 represent only a fraction of those which may be carrying loads that could be

Table 6-1

CONTAINERIZED LOADS

14th Support Group Units

No. in support group area	Unit type	Vehicle type and load 2.5 ton chassis Electronics van	Gen. set	Inst. rep. shop	Lab. van	Shop van	Fire control van	Total
2	1-77G Air mbl co lt					2		2
1	1-128G Avn air survl co	3				1		4
2	1-258G Avn med hel co	1				3		4
6	5-35G Eng cbt co					2		2
2	5-58G Eng lt equip co					4		4
2	5-64T Eng aslt brg co					2		2
1	5-124G Eng dump trk co					2		2
1	5-327G Eng topo co				2	13		16
5	6-415E 8-in. how bn sp					7		7
2	6-425G 155 how bn towed					1		1
3	6-435G 175 bn sp					1		1
1	6-501G Hhb corps arty	2				3		5
2	6-525E HJ bn					4		4
1	6-555G Sgt bn					8		8
1	6-575F Tgt aq bn					19		19
1	8-137G Med air amb co					1		1
1	9-47E Ord sp ammo ds co					2		2
1	9-86G Hhc ammo bn ds/gs					2		2
1	9-227G Ord gm gs co					13		13
1	11-86F Hhc sig cbt area bn	15		1				16
4	11-87F Sig cbt area co	25	1	1				27
1	11-147F Sig sm hq op co	8		1				9
1	12-17G Spec service co					14		14
1	12-605G Army postal unit					1		1

Table 6-1 (Cont'd)

No. in support group area	Unit type		Vehicle type and load 2.5 ton chassis Electronics van	Gen. set	Inst. rep. shop	Lab. van	Shop van	Fire control van	Total
1	29-102F	Hhc gen spt gp	1						1
3	29-137G	Hv eq gs maint co					4		4
1	29-139F	Col cls sal co					3		3
1	29-134G	Lt eq gs maint co					8		8
2	29-206F	Hq main spt co	1				6		7
2	29-207F	Lt maint ds co			1		6		7
1	29-217G	Sup and svc co					1		1
2	32-57F	ASA supt co div	1		3				4
1	44-12F	Hhb ADA gp	2						2
3	44-235G	Hawk bn	1					34	35
2	55-457G	Tr afct ds st co		1					1
1	55-458G	Tr afct maint co		2					2
Totals			40	8	14	2	209	102	475
Total assigned drivers									1

containerized. However, since the objective of this portion of the study was to examine chassis pooling in concept only, it is felt that those vehicles selected are a clearly typical sample and are sufficient for purposes of analysis.

SIMULATION OF POOLED CHASSIS FLEET PERFORMANCE

Introduction

The 475 vehicle chassis extracted from the current fleet as shown in the previous section were pooled in a centralized location and their performance as a pooled fleet simulated in a manner analogous to that used for unit moves in the cargo fleet pooling analysis. Using the same combat scenario, mission demands for the chassis fleet were generated by unit moves. When a unit move was necessary, the unit having containers to be moved requested the appropriate number of vehicles from the centralized pool. These vehicles were then dispatched as available, proceeded to the requesting unit, loaded the containers at the "old" unit location, traveled to the new unit location and unloaded the containers. At this point the container move mission was considered complete and return travel time of the chassis vehicles is not included in mission completion time. Of course return travel time enters into overall fleet performance since the vehicles involved are unavailable to service other requested missions and mission delay time is thus generated.

All simulation inputs used for the container fleet simulation are the same as those used in the cargo fleet simulation except of course mission payload (2.5 tons per container), and the vehicle fleet sizes which are simply percentage reductions of the total 475 vehicle chassis made available for pooling. Vehicle speed (40 kph) and maintenance parameters remain the same as those for $2\frac{1}{2}$ ton cargo vehicles. Load/unload rates for containers were set at a conservative 30 minutes for load or unload in the absence of firm data from study sources on containerization.

Vehicle Fleet Simulation Results

Figures 6-1 and 6-2 portray the results of fleet performance simulation in terms of mission dispatch delays and mission completion times over the 15 day combat scenario. The performance of the current

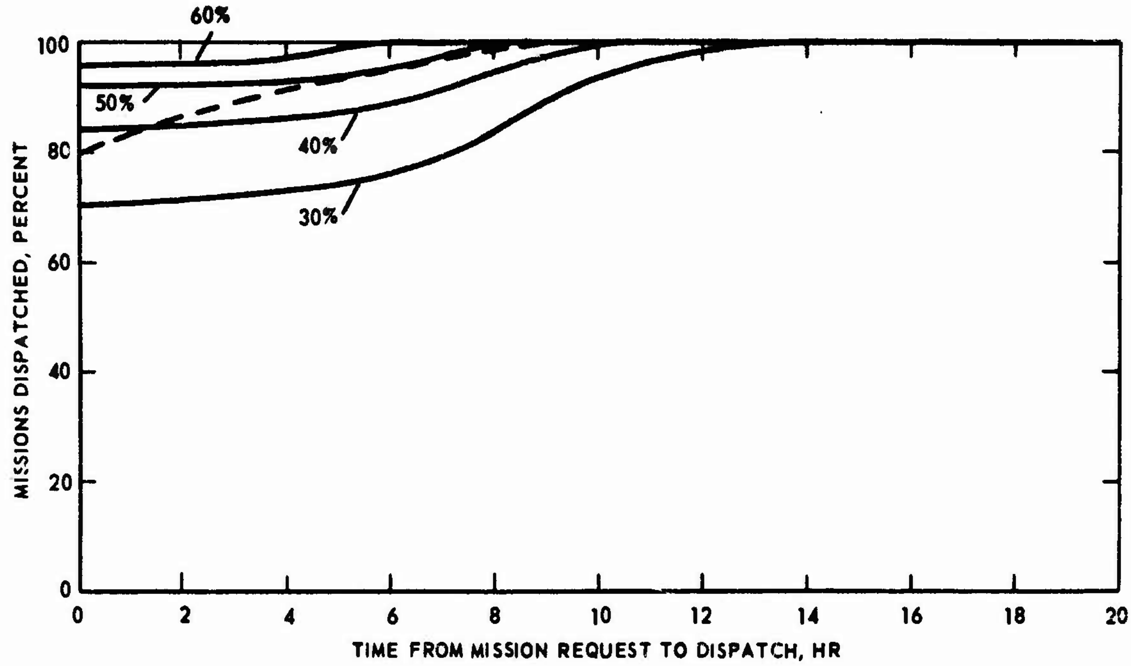


Fig. 6-1—Cumulative Mission Dispatch Times—Containerized Loads

– – – Current fleet ——— Pooled fleet

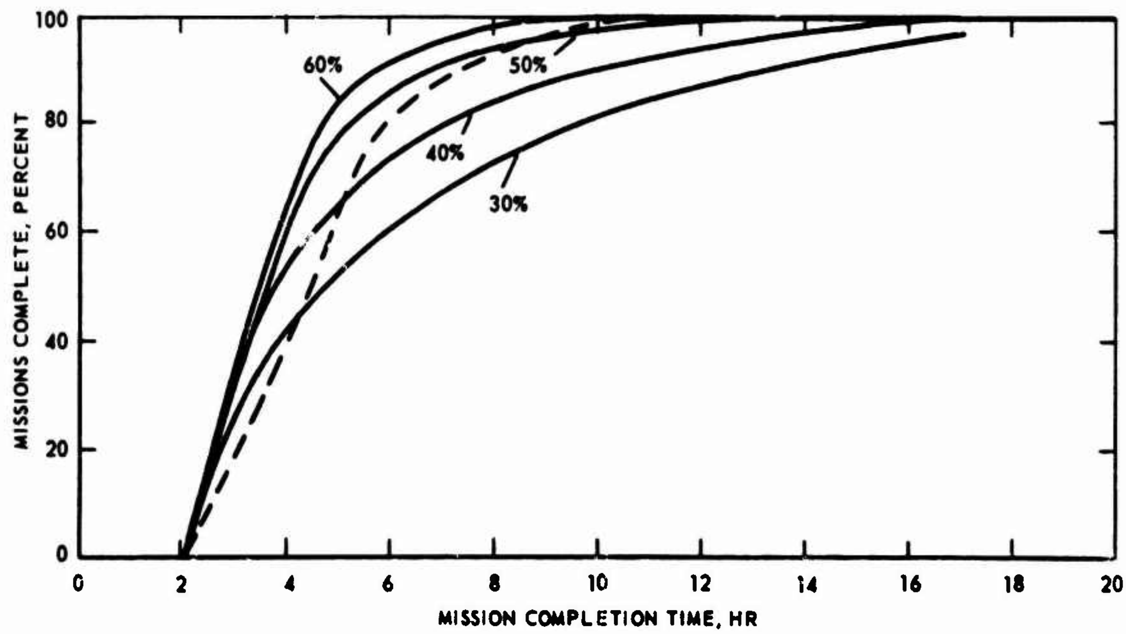


Fig. 6-2—Cumulative Mission Completion Times—Containerized Loads

– – – Current fleet ——— Pooled fleet

fleet and pooled fleets of 60, 50, 40, and 30 percent of the 475 vehicle chassis available (285, 238, 190, and 143 vehicles respectively). Both the mission dispatch delay and mission completion time results indicate that a pooled chassis fleet of 50% of the total number of vehicles made available by pooling provides performance equivalent to that of the current fleet. At this level of performance over 92% of container move missions experience no delay in mission dispatch and all missions are dispatched within 8 hours of time of request. More importantly, the 50% pooled chassis fleet shows completion of 95% of requested missions within 8 hours, a figure very close to the simulated performance of the current fleet.

Potential Fleet Cost Savings

Table 6-2 shows a cost comparison between the current fleet of 475 vehicles with fixed loads and the 50% pooled chassis fleet which provides approximately equal simulated fleet performance. This cost comparison must be viewed with caution because of the assumptions necessary in its construction. Without a significant amount of time and effort is is impossible to obtain separate costs for vehicle chassis and the loads carried. Thus the costs used were 12 year life cycle costs for $2\frac{1}{2}$ ton shop vans ($42,245) for current fleet cost estimates. Costing of the pooled fleet alternative is based on the cost of $2\frac{1}{2}$ ton cargo vehicles ($35,310) as being roughly equivalent to $2\frac{1}{2}$ ton chassis costs, and the cost of the containerized loads as the difference between the two vehicle costs ($6,935 per load). Although it is known that in the absolute dollar sense the comparison is not rigorous, the relative picture of the cost impact of reducing the number of chassis required through pooling should be roughly correct.

As can be seen from Table 6-2 however the details of vehicle costing become insignificant when compared with the issue of driver costs. The necessity of providing assigned drivers for the pooled chassis fleet versus the current policy of using additional duty drivers almost exclusively to drive the vehicles involved pushes the total cost of the pooled chassis fleet to a level higher than that of the current fleet.

In summary it would seem that the issue of containerizing many of the loads now fixed to vehicle chassis is dominated almost entirely by assigned driver costs and appears to offer little cost saving for this reason. It must be remembered in addition that the preceding cost analysis does not include additional costs for load/unload devices for the containers. These would have to be available, either on the chassis or at the using unit and would, of course, add to the cost of the container fleet.

Table 6-2

COST COMPARISON OF CURRENT AND POOLED CONTAINER FLEETS

	Current fleet	Pooled chassis fleet
Number of vehicles	475	238
Vehicle type	$2\frac{1}{2}$ ton shop van	$2\frac{1}{2}$ ton cargo
Unit cost	$42,245	$35,310
Total vehicle cost	20,066,375	8,403,780
Number of loads	475	475
Unit cost	Incl. in vehicle cost	$6,935
Total cost	Incl. in vehicle cost	3,094,125
Number of assigned drivers	1	286[1]
Assigned driver cost	103,200	29,515,200
Number of additional duty drivers	474	0
Additional duty driver costs	5,688,000	0
Total fleet cost	25,857,575	41,013,105

1. At a ratio of 1.2 drivers per vehicle

Chapter 7

POOLED FLEET ALTERNATIVES AND THE REVAL WHEELS SYSTEM

Total inclusion of the tactical vehicle pooling analysis methods developed in this and the preceding RAC study into the REVAL WHEELS fleet planning model is not possible due to fundamental differences between the two models. REVAL WHEELS is vehicle task and force structure oriented, essentially matching vehicles and payloads and applying appropriate multipliers to arrive at total fleet size and cost for the entire army force structure. On the other hand, the models developed in the tactical vehicle pooling studies are less oriented toward total force structure and more detailed in the consideration of the dynamics of mission performance within the vehicle task types selected for analysis. A fundamental difference between the two modeling systems is the use of mission frequency as well as mission type in the pooling methods developed. The REVAL system considers only the task to be performed by a vehicle - not it's frequency of occurrence.

Even though the two fleet planning models cannot be totally integrated at the present time, it would be possible to input the results of a particular vehicle pooling analysis into the REVAL system and assess the implications on total force structure. For example, the alternative pooled cargo fleet remix B which was found in Chapter 3 to provide approximately equal performance to the current fleet could be used as a basis to extract tasks and associated vehicles from the REVAL task data tape. These tasks and associated vehicles could then be lumped into a "dummy" SRC with the number of vehicles required reduced to match the numbers and types of vehicles comprising fleet remix B. This dummy SRC would then be reinserted into the REVAL system with the appropriate multipliers, i.e., the number of pooled cargo

fleets at the corps support group level required for the entire Army force structure.

The extraction and reduction routine just described is shown in flow chart form in Fig. 7-1 while the exit and re-entry points of this routine within the entire REVAL system are shown in Fig. 7-2.

Many of the details of the process remain undone since the REVAL model itself is undergoing revision and it is at present unclear exactly at what point in the REVAL model the pooled fleet vehicle results and force structure multipliers should be inserted. In the interim however, it is possible to make gross estimates of the vehicle and associated cost savings which could result from implementation of the pooled fleet organizations examined in this study. All that is necessary is to postulate a force structure, derive the number of corps support groups within the force structure, and by simple multiplication compute the potential cost savings. Table 7-1 illustrates this procedure for a twelve division, three corps field army. Included in this force would be six corps support groups (two per corps support brigade). As seen from the table, total potential cost savings through pooling amount to as much as $341.4 million over a twelve year fleet life cycle. It should be borne in mind that these potential cost savings are only those resulting from the specific analyses included in this report and do not include possible cost savings from other applications of vehicle pooling, specifically those found at the division level in previous work.

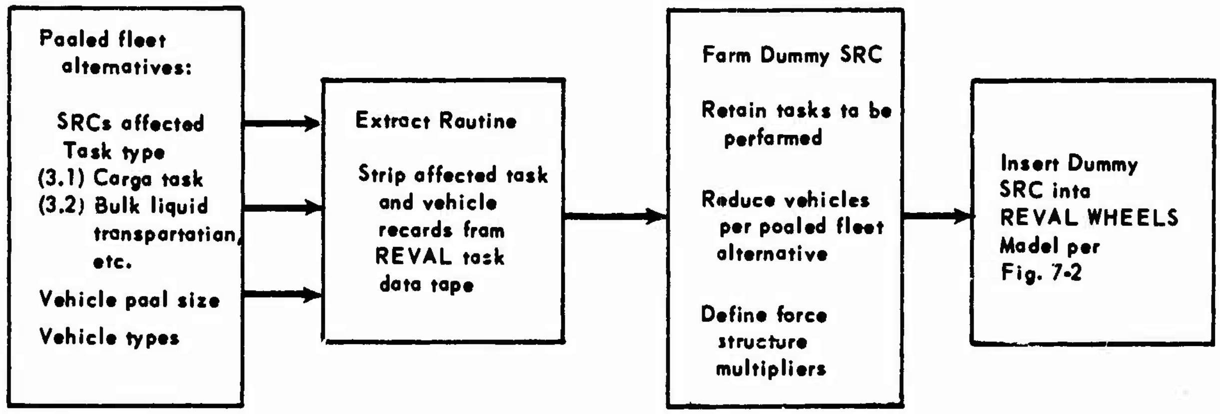


Fig. 7-1—Pooled Fleet Alternative Routine for REVAL WHEELS

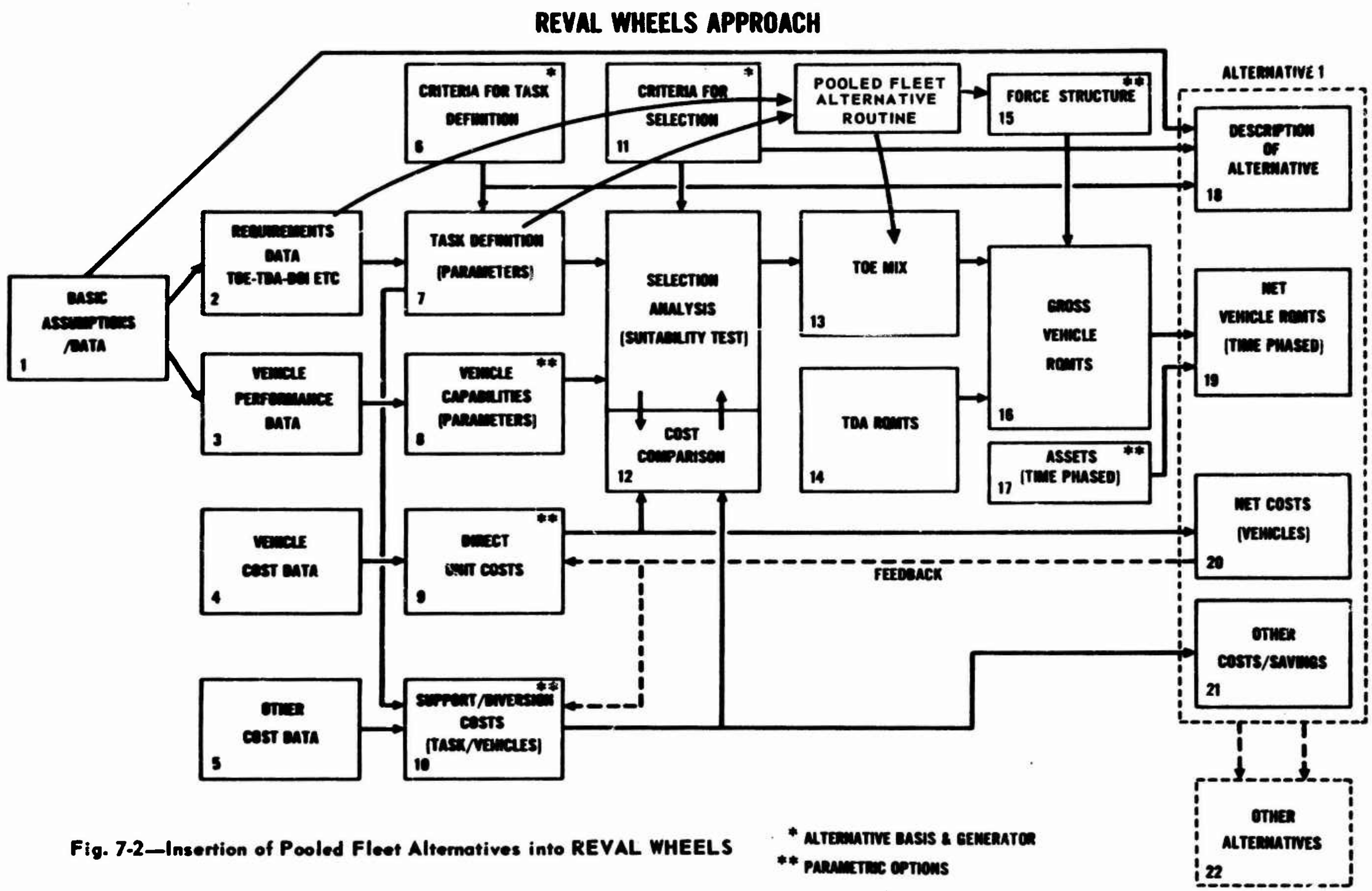


Fig. 7-2—Insertion of Pooled Fleet Alternatives into REVAL WHEELS

* ALTERNATIVE BASIS & GENERATOR
** PARAMETRIC OPTIONS

RAC

Table 7-1

POTENTIAL VEHICLE AND COST SAVINGS THROUGH POOLING
FOR A TWELVE DIVISION FIELD ARMY

Task	Current fleet size[a]	Pooled fleet size[b]	Vehicle savings	Current fleet costs[c]	Pooled fleet costs	Cost savings
Cargo transport	6714	2430	4284	$607.8	$369.0	$238.8
Bulk fuel transport	714[c]	402	312	130.2	81.6	48.6
Maintenance vehicle operations	2490	1422	1068	162.0	108.0	54.0
Total vehicle and cost savings			5664			$341.4

[a]Based on corps support group fleet times six.

[b]Pooled fleet alternatives are those shown to be most comparable with current fleet performance in the analyses of the preceding chapters.

[c]All costs are 12 year life cycle costs (including drivers) in millions of dollars.

[d]Current fleet size shown is not the total number of fuel tankers in the current corps support group area. The fleet shown is that portion of the total which could be removed from using units without leaving the units with no fueld storage.

Appendix A

SIMULATION METHODOLOGY

INTRODUCTION

The basic tool used in the analysis of pooling opportunities is a stochastic simulation of vehicle fleet operations. This simulation produces a number of fleet performance parameters for given fleet sizes, mixes, and organizations exercised against a demand spectrum for the services of the vehicle fleet. The performance measures thus generated are then used in comparing the ability of pooled vs non-pooled fleets in meeting demand for vehicle missions. The simulation is generalized enough to allow its usage in evaluating a broad range of fleet performance problems in addition to the vehicle pooling analyses included in this study.

The documentation of the simulation method presented in this appendix concentrates upon the conceptual flow of the simulation. Only sufficient detail to enable the reader to grasp the use of the simulation in the analysis of the pooling problems presented in the main body of the report is presented here. Complete documentation of the models, including detailed flow charts and user instructions are contained in Appendices F and G., Volume III of RAC-TP-420.[7]

As indicated in Chapter 2, the vehicle fleet performance simulation used in this research effort is basically the same model used in the predecessor study, RAC-TP-420, "Analysis of Opportunities for the Reduction of Tactical Vehicles Through Pooling." This simulation has now been modified in several respects, primarily to increase the utility of output results and to reduce the volume of pre-simulation calculations required in determining mission input parameters.

One major change was to provide for input in the form of grid coordinates of units served by vehicle pools and to allow computation of mission radii by the simulation on a daily basis. This change also incorporates the ability to move units within the simulation run according to input unit move frequencies. Previously, a mission radius to each unit on each day of a simulation run had to be hand calculated prior to running the simulation.

The second major change to the simulation provides for computation and output of mission completion time in the form of a total frequency distribution. Previously mission completion times were available only in average value form.

BASIC VEHICLE FLEET PERFORMANCE SIMULATION

Figure A-1 is a schematic of major simulation operations, and shows the flow of activities which occur during one time slice of simulated fleet operations. The simulation can run for any given period of operation days and each day is subdivided into time slices or increments. These increments are chosen of such magnitude that time accuracy of simulation output is achieved and that time assumptions for stochastic input variables are met. For instance, specification that certain unscheduled missions occur according to a Poisson distribution depends upon time intervals being small enough that the probability of mission occurrence in any one time interval is relatively small.

From the schematic it can be seen that the simulation handles basically two types of missions. The request of these missions, pre-planned or unscheduled, initiates simulation activity. Pre-planned missions are submitted to the vehicle dispatcher daily or in a list for the entire simulation duration. On the other hand, unscheduled missions are requested as they are generated by random demands for vehicle services by the organizations using the vehicle pools.

Upon receipt of a mission request, the vehicle dispatcher routine (see Fig. A-2) notes the priority of the mission requested and evaluated this priority in comparison with the priority of all other

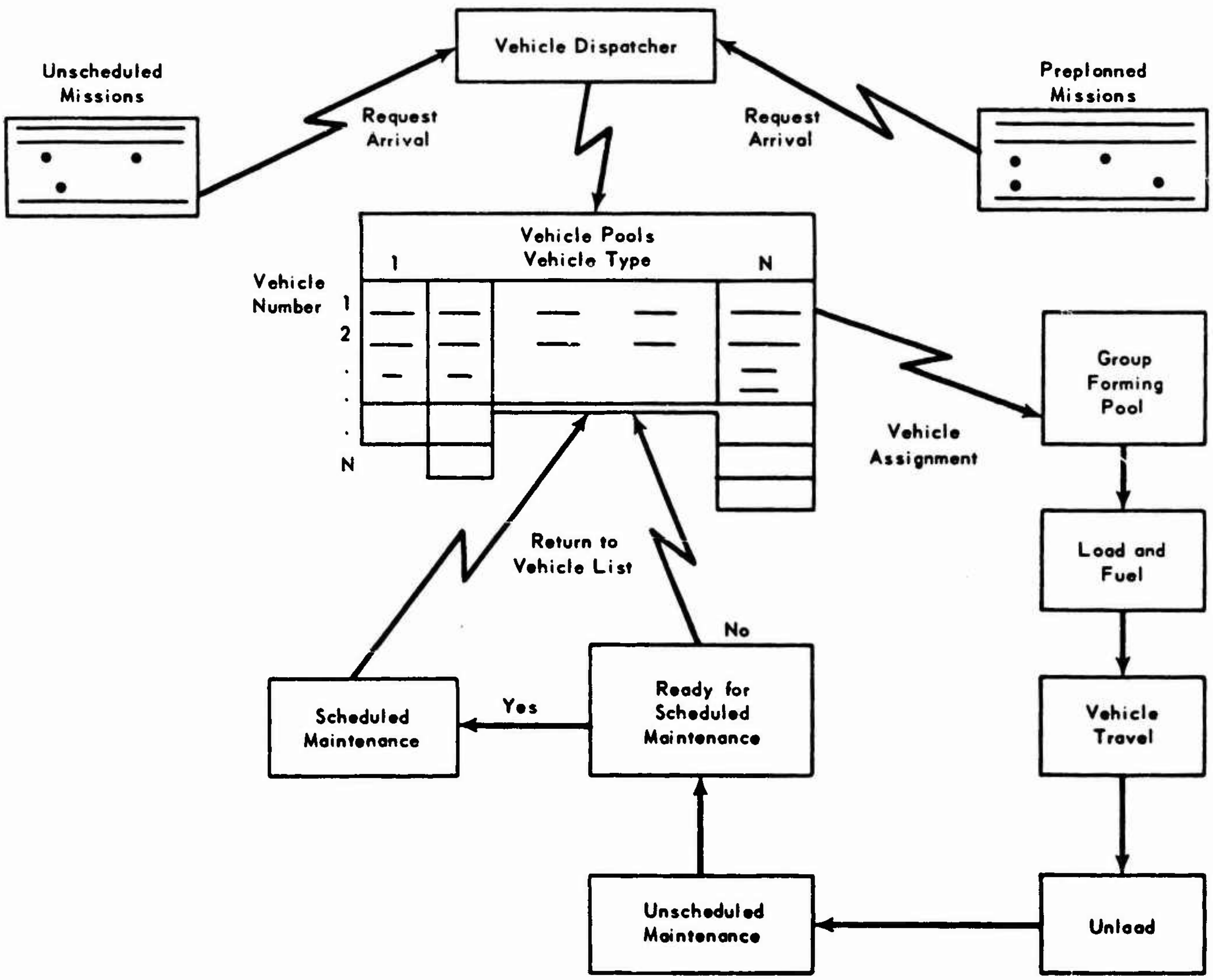


Fig. A-1—Simulation Schematic

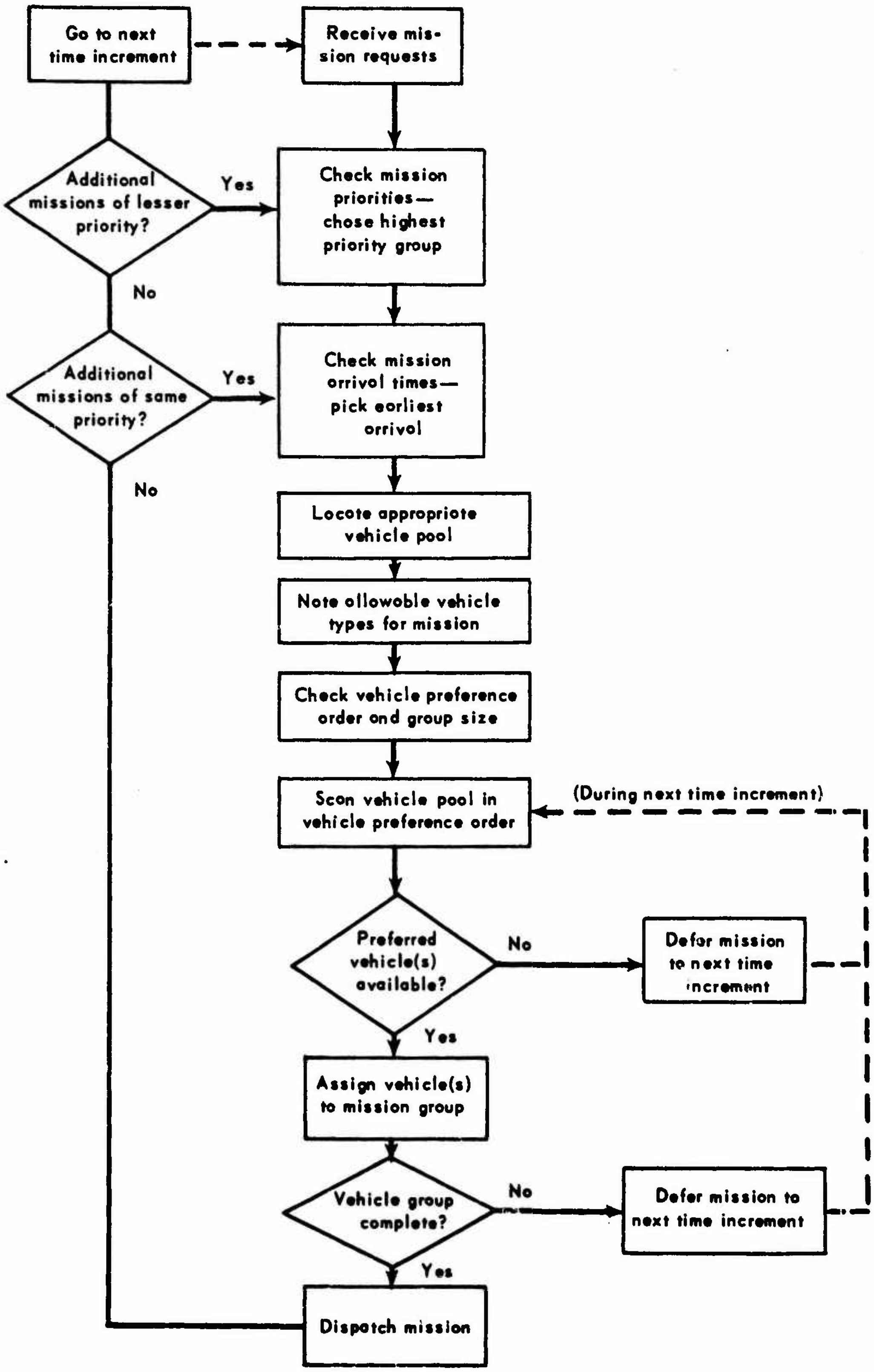


Fig. A-2—Mission Dispatch Routine

mission requests made during the same time interval. Missions are served by the vehicle dispatcher in priority order during any specific time slice. All priority 1 missions are dispatched first, then priority 2, and so on. Within groups of missions of the same priority, mission serve or vehicle dispatch is on a first-come first-served basis.

When a requested mission is ready to be served by the vehicle dispatcher, the dispatcher notes the vehicle pool from which the vehicle to perform the mission is to be taken and the vehicle types within this pool that are allowed to perform the mission. Among these vehicle types, the vehicle dispatcher scans the vehicle fleet for vehicles available to perform the mission. This scanning is done in the order of vehicle preference specified for the type of mission requested. That is if more than one vehicle type is allowed to perform the mission requested, the dispatcher will search for vehicles of first preference, then second preference and so on.

Proceeding in this manner the vehicle dispatcher will form a group of vehicles (if more than one vehicle is required) to perform the mission. This formation of vehicle groups can proceed under either one of two sets of rules. If homogeneous group serve is requested, vehicle groups will be formed from only one vehicle type. If combination serve is requested, the dispatcher forms a group of vehicles from those vehicle types most readily available.

If in scanning the vehicle pool fleets, the dispatcher finds no vehicles of the proper type to assign to the mission, the mission is deferred until the beginning of the next time increment, when the whole process begins again. If some but not all of the proper vehicle types are located, those found are placed in a group forming pool and in the next time increment (or succeeding increments) the search for vehicles is continued until the required number are found. If the proper vehicles are found during the initial search, of course, the vehicle group is dispatched immediately to perform the mission.

Upon mission dispatch the vehicles are loaded and fueled, proceed to the mission destination, unload and return as shown in Fig. A-3. Before the vehicles are returned to availability, however, the vehicles are checked by the maintenance routines for the necessity of scheduled

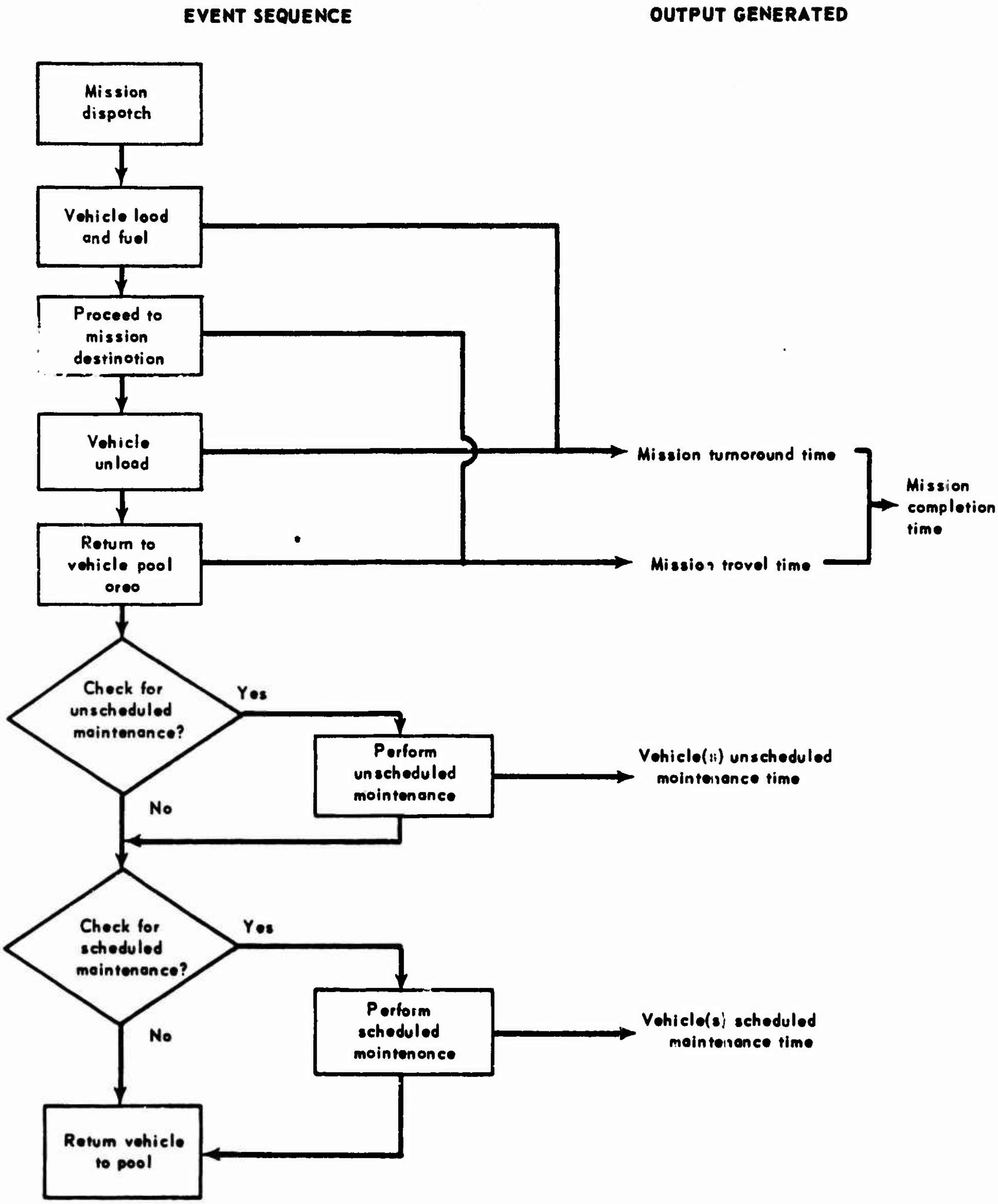


Fig. A-3—Mission Performance and Maintenance Routines

*Return travel time is not included in some mission completion times depending on the specifics of the problem under analysis. See Chap. 3, pp 3 to 21.

or unscheduled maintenance. The need for unscheduled maintenance is determined by drawing a random number and comparing it with a distribution of unscheduled maintenance occurrences generated from basic input data on vehicle reliability and maintainability. If by this process it happens that the vehicle draws unscheduled maintenance, another similar random process generates the appropriate unscheduled maintenance time. The form of both these unscheduled maintenance distributions and their necessary parameters are part of the simulation input.

Upon completion of unscheduled maintenance or if no unscheduled maintenance is assessed against the vehicle, a check of each vehicle's maintenance history is made to see if the vehicle has accumulated enough operating hours for scheduled maintenance to be necessary before returning the vehicle to the available fleet. If so, a number of scheduled maintenance hours (dependent upon vehicle type) are allowed to elapse before the vehicle is allowed to perform further missions. In checking the need for scheduled maintenance a threshold is also employed such that if the vehicle is not quite due for scheduled maintenance but would be due before completion of the next assigned mission, the vehicle goes to maintenance before returning to its vehicle pool. This maintenance threshold is based upon average mission durations.

Following the maintenance routines the vehicle cycle is complete and the vehicle is returned to the appropriate pool. Of course during this cycle of vehicle operations, other vehicles are dispatched and perform requested missions as the time increments of simulation cycle forward in time. As the simulation proceeds, detailed statistics for all vehicles and missions are accumulated and become the basis for simulation output parameters.

SIMULATION INPUT DATA

Operation of the fleet performance simulation requires three basic types of input data: mission definitions and demand schedules, vehicle type and vehicle fleet characteristics, and simulation operational parameters such as duration, time increments, length of operating day, etc.

Mission Definition and Demand Schedules

The types of missions that can occur during the period of the simulation must be uniquely defined and their frequency of occurrence specified. Mission definition is primarily a function of the problem being attacked. Mission types are defined for each specific job to be performed; for instance in the case of cargo and bulk fuel transport, each mission type was defined by the kind of cargo transported, the amount being carried, and the destination of the cargo (the requesting unit). On the other hand, in the simulation of maintenance vehicles operations, some mission types were defined by the location of units requiring contact maintenance.

Once the job to be done is specified, certain inputs must be defined for each mission type. These are:

mission priority (with respect to other mission types)

mission payload

mission radius or unit location and frequency of unit move

the vehicle pool which serves a request for the mission, and

vehicle types allowed to perform the mission

Once mission types are defined, a demand schedule is prepared which specifies the frequency of occurrence of each mission type based upon demand for missions. For preplanned missions this consists of the number of missions of each mission type (by priority) for each time increment in the simulation operating day. For unscheduled missions the probability of occurrence of each mission type in each time increment is computed by the simulation when the frequency of mission types per operating day is specified.

Vehicle Fleet and Vehicle Type Input Data

For each vehicle pool serving missions requested during simulation, the vehicle types and the number of each type must be specified. In addition, for each vehicle type the following inputs are required:

scheduled maintenance interval and duration (operating hour basis)

unscheduled maintenance interval and duration distribution (on either operating hour or per sortie basis)

scheduled maintenance threshold

"age" of each vehicle (scheduled maintenance history)

vehicle load/unload rate

vehicle operating speed, and

vehicle payload.

Mission/Vehicle Interdependency Parameters

The fleet operations simulation as presently configured computes certain parameters that are not strictly input data, but that are computed by a pre-processor routine prior to each simulation run. These parameters are:

mission duration for each vehicle type/mission type combination,

mission turnaround time for each vehicle type/mission type combination, and

vehicle group size for each mission type and vehicle type.

Simulation Operational Parameters

Each simulation run requires specification of the following parameters:

simulation duration (days)

mission request start/finish time

mission assignment start/finish time

work day start/finish time

mission discipline

vehicle assignment discipline, and

vehicle group forming discipline.

Except for the last three, these terms are obvious in their meaning. Mission discipline refers to a set of options available to deal with missions not completed within a specified time interval (usually one operating day). Such missions can be (1) canceled, (2) forced to completion within a set interval, or (3) carried over to the succeeding operational day.

Vehicle assignment discipline is a set of two options which specify the order in which vehicles of any one type are chosen by the vehicle dispatcher to perform missions. In the first option, the vehicle dispatcher begins scanning the list of vehicles with the vehicle number immediately following that of the last vehicle of that type used. This option tends to spread utilization of vehicles of any one type over the total number in the fleet. The second option has the vehicle dispatcher always begin his scan with the first vehicle number of a given type, thus minimizing the number of vehicles utilized. The latter option is most useful when it is desired to determine minimum fleet sizes necessary to perform a given set of missions. The first option is used to obtain maximum utilization of predetermined fleet sizes.

Vehicle group forming discipline has already been discussed to some extent (p A-4). As was shown the vehicle dispatcher routine can be set to form groups of either all one type of vehicle (homogeneous groups) or from a mix of vehicle types according to availability.

SIMULATION OUTPUT

The total array of simulation outputs is quite large since the model was designed to analyze a wide variety of problems. Only those output parameters needed for analysis of fleet performance in pooling problems are defined here. Readers interested in the simulation <u>per se</u> and applications to other problems are referred to Appendix F, Volume III, RAC-TP-420.

Fleet performance output parameters used in this analysis are as follows for each mission type:

- total number of missions requested
- total number of missions completed, etc.
- total number of missions not met
- total number of missions delayed
- total mission delay time
- total group forming waiting time
- average mission delay time
- average delay (missions delayed)
- standard deviation of mission delay time

skewness of mission delay time distribution

a histogram of mission delay times

a histogram of mission completion times

In addition, a summary of mission performance over all mission types is given including all of the output. The following fleet and vehicle performance data is also obtained with each simulation run for each vehicle type:

number of vehicles available

number of vehicles utilized, etc.

total operating time

total scheduled maintenance time

total unscheduled maintenance time

total turnaround time (loading/unloading/
fueling

total group forming waiting time, and

total idle time.

Totals of each of these parameters over the entire fleet are also output.

Appendix B

DERIVATION OF UNIT MOVE FREQUENCIES

As noted in Chapter 3, the mission demand placed upon a vehicle fleet as a result of unit moves is a function not only of the unit move payloads but in addition the frequency with which these payloads must be moved, i.e., unit move frequencies.

A literature search of logistics planning and war-gaming documents yielded very little specific information on the frequency of unit moves at various levels of conflict for the combat service support units that are the primary focus of this study. As a result, frequency of move for these units had to be derived based on data which was available.

Unit move frequencies obviously depend on the state of flux in the combat situation under consideration. The measure of this state of flux which is most readily available from most war games and scenarios is the rate of movement of the forward edge of the battle area (FEBA). Table B-1 presents the results of a survey of FEBA movement rates taken from the sources noted and including war games, logistic exercises, and historical data from actual campaigns involving forces as large as field armys. As seen, the range of FEBA movement rates is from 1.4 to 29 kilometers per day.

Using the rate of FEBA movement as a base, frequency of unit move data for the combat support and combat service support units of interest in this study were derived. The derivations were governed by two key criteria. First, artillery units must move with sufficient frequency that continuous fire support is available to combat units on the advancing FEBA. Second, the movement of other combat support and service support units must be often enough to assure that distances

Table B-1

RANGE OF FEBA MOVEMENT RATES

Data Source	Attacking Force/Operation	Opposing Force	Rate of FEBA Movement-km/day
LOGEX-71 Study - Transportation Agency - Ft. Lee	30th U.S. Army/ Counterattack	Warsaw Pact	10-20
RAC-TP-266, "Computerized Quick Game: A Theater-Level Combat Simulation (U)"*	Armored-Mechanized Divisions/Attack	Armored-Mechanized Divs.	
		- Prepared Position Defense	1.4
		- Hasty Position Defense	4.5
		- Meeting Engagement	9.4
		- Delaying Action	18.3
		- Orderly Retirement	29.0
ORO-TP-10, "Rates of Advance in Land Attack Against Unprepared Forces"	Japanese-Malayan Operation, 1941-42	British Infantry/ Armor	10.8
	North Korean Invasion, 1950	ROK/US	11.7
	German Invasion of Russia, 1941 - 1st 35 days	Russian Army	18.5
	German Invasion of Low Countries	British, French	25.8

*Original data from U.S. Army War College, Force Ratio 2:1, Open Terrain

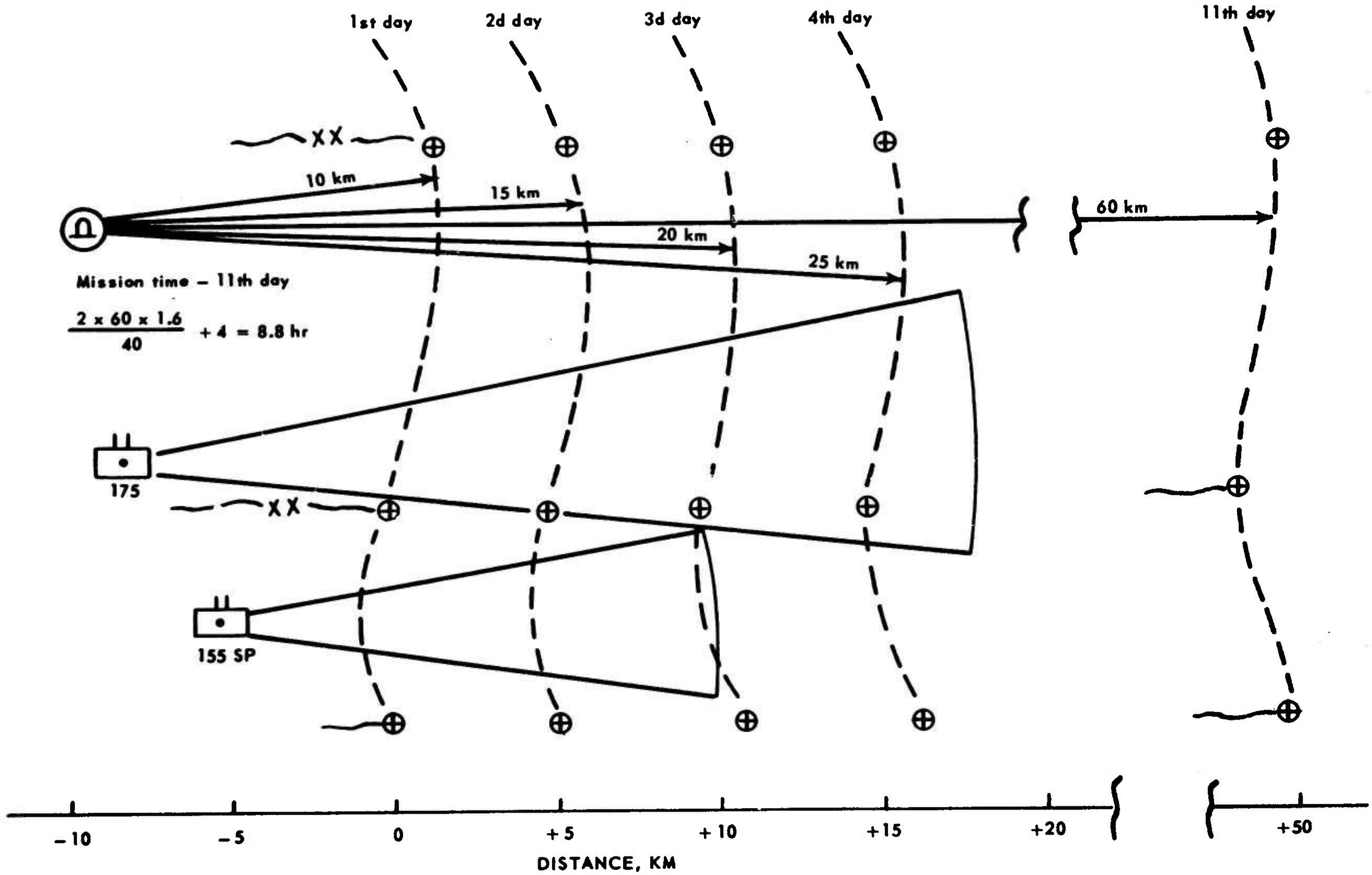


Fig. B-1—Frequency of Unit Moves
FEBA movement rate: 5 km/day.

between these units and the combat units supported were sufficiently small to allow round trip travel between supported and supporting unit within a single operating shift, i.e. 10 hours.

Using these two criteria the necessary frequency of unit moves for artillery and other units was computed for FEBA movement rates ranging from 2 to 20 kilometers per day. Calculations for artillery units are based on the range of the weapons and their initial distance behind the FEBA (immediately following a move) being one-third the range of the weapons. An example in graphic form of the calculations is shown in the lower half of Fig. B-1 for a FEBA movement rate of 5 km per day. In the example shown, 155mm howitzer units must move at least once every 3 days to provide fire support and the 175mm guns are required to move at least every 4 days. Since multiple units of each type of weapon are included in a field army force, their movement at these frequencies on alternating days would provide continuous fire support to combat units on and ahead of the FEBA.

The upper portion of Fig. B-1 shows in graphic form the derivation of unit move frequencies for combat service support units such as ordnance units. Assuming a 4-hour period for load and unload of vehicles on any one trip, the remaining 6 hours of a 10-hour shift are available for travel to the area of the FEBA and return. At a FEBA movement rate of 5 km/day and assuming on-road vehicle speeds of 40 kph, the unit would be required to move only once every 10-12 days to remain within the criterion distance behind the FEBA.

Using the method just outlined, unit move frequencies over the range of 2-20 kilometers per day of FEBA advance were calculated and the results were presented in Table 3-5. Of course the frequencies used in the simulations reported in the main body of the report are those derived from 10 and 20 kilometer per day FEBA movement rates per the LOGEX 71 scenario.

Appendix C

SIMULATION INPUT — UNIT AND MISSION PAYLOAD DATA

This appendix presents in complete tabular form the mission payloads used in vehicle fleet simulation of cargo, tanker and container fleet alternatives. Each table, in addition, shows all of the units operating in the 14th Support Group area, their number designation in the 30th U.S. Field Army per LOGEX 71, their authorized personnel strength, and UTM grid coordinates at the start of each simulation run.

Tables C-1 through C-4 deal with cargo fleet simulation input; with Tables C-5 and C-6 showing input for the tanker pooling and container problems.

Table C-1

CARGO FLEET SIMULATION UNIT
AND MISSION PAYLOAD INPUT

Attack Posture - Light Unit Move Payloads

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
01077G600	AIR MBL CO LIGHT	184	189	MV7058	1.500	2.730	
01077G600	AIR MBL CO LIGHT	182	189	MV7173	1.500	2.730	
01111T710	AVN AIR WPNS CO	196	189	MV9355	2.600	2.660	13.50
01128T600	AVN AIR SURVL CO	139	183	MV7671	7.250	2.580	
1252G600	HHC AVN GP	102	76	MV8749	.0000	1.072	
01256G600	HHC AVN BN	114	77	MV7173	4.900	1.086	
01256G600	HHC AVN BN	115	77	MV7551	4.900	1.086	
01258G600	AVN MED HEL CO	159	239	MV7058	1.450	4.800	
01258G600	AVN MED HEL CO	160	239	MV7173	1.450	4.800	
03267G600	CML SMOKE GEN CO	324	147	NV1180	58.00	2.073	
03267G600	CML SMOKE GEN CO	827	147	MV8749	58.00	2.073	
03267G600	CML SMOKE GEN CO	326	147	MV9845	58.00	2.073	
05035G600	ENGR COM BI	521	836	MV7374	18.85	5.440	2.740
05035G600	ENGR COM BN	514	836	MV8749	18.85	5.440	2.740
05035G600	ENGR COM BN	515	836	MV8858	18.85	5.440	2.740
05035G600	ENGR COM BN	508	836	MV9090	18.35	5.440	2.740
05035G600	ENGR COM BN	511	836	NA0202	18.35	5.440	2.740
05035G600	ENGR COM BN	513	836	NV0746	18.35	5.440	2.740
05052E600	HHC ENG CMBT GP	67	114	MV7244	10.50	1.607	.0000
5054G710	ENG LT EQ CO ABN	5065	212	MV7144	3.000	1.770	.3600
5054G710	ENG LT EQ CO ABN	5066	212	MV7144	3.000	1.770	.3600
5064T100	ENG ASLT BRDG CO	5072	205	MV9555	3.700	2.891	.0000
5064T100	ENG ASLT BRDG CO	5073	205	MV7787	3.700	2.891	
05077E000	ENG PANEL BRG CO	5039	129	MV9545	.6500	1.819	
5077E000	ENG PANEL BRG CO	5038	129	NV0746	.6500	1.819	
05078G600	ENG FLT BDG CO	5058	234	MV9545	5.850	3.299	
5124G600	ENG DUMP TRK CO	5009	114	MV7742	1.450	1.607	
5327G600	ENG TOPO CO	5001	143	MV7960	13.00	2.016	
6401G600	HHB FA GROUP	66	135	MV9246	6.500	1.904	
6401G600	HHB FA GROUP	65	135	NV0496	8.500	1.904	
06401G600	HHB FA GROUP	64	135	NV0673	6.500	1.904	
06415E300	81N SP BN	620	618	MV9286	135.6	3.190	97.47
06415E300	81N SP BN	621	618	MV9366	135.6	3.190	97.47
6415E300	81N SP BN	618	618	NV0749	135.6	3.190	97.47
06415E300	81N SP BN	612	618	NV1590	135.6	3.190	97.47
6415E300	81N SP BN	613	618	NV1699	135.6	3.190	97.47
6425G600	155 T BN	654	563	NV2388	146.1	3.030	103.7
06425G600	155 T BN	653	563	NV1968	146.1	3.030	103.7
06435G700	175 SP BN	662	550	MV9157	97.20	3.050	103.7
06435G700	175 SP BN	664	550	MV9970	97.20	3.050	105.7
06435G700	175 SP BN	663	550	NV0039	97.20	3.050	105.7

RAC

Table C-1 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
06455G700	155 SP BN	634	506	NV0655	52.70	2.870	102.5
6455G700	155 SP BN	636	506	NV1396	52.70	2.870	102.5
6455G700	155 SP BN	632	506	NV1541	52.70	2.870	102.5
06455G700	155 SP BN	635	506	NV2297	52.70	2.870	102.5
06501G600	HHB CORPS ARTY	2	211	MV8939	12.65	2.975	
06525E400	HJ BN	108	408	MV9697	17.70	5.753	
06525E400	HJ BN	107	408	NV2065	17.70	5.753	
06555G700	SGT BN	212	377	MV7481	20.90	5.316	
6575E600	TGT AQ BN	102	768	MV8999	13.85	10.83	
08122G600	HHD MED GP	83	37	MV7867	8.000	.5217	
8126G600	HQ HC DET MED BN	803	39	MV6553	1.450	.5499	
8127G600	MED AMBL CO	8010	102	MV7565	2.400	1.438	
8127G600	MED AMBL CO	8011	102	MV8848	2.400	1.438	
08128G600	MED CLRNG COMPY	8630	130	MV7565	2.600	1.833	
08137G600	MED AIR AMB CO	8001	202	MV7867	7.300	2.848	
08571E400	MOB AR SURG HOSP	8097	121	MV6553	5.550	1.706	
08571E400	MOB AR SURG HOSP	8096	121	MV9948	5.550	1.706	
08571E400	MOB AR SURG HOSP	8095	121	NV0687	5.550	1.706	
08581E400	EVACUATION HOSP	830	318	MV6848	4.750	4.434	
08581E400	EVACUATION HOSP	829	318	MV9593	4.750	4.484	
09017G700	ORD AMMO DSGS CO	9011	315	MV9065	39.40	4.442	
09017G700	ORD AMMO DSGS CO	9009	315	MV9860	39.40	4.442	
09017G700	ORD AMMO DSGS CO	9008	315	MV9570	39.40	4.442	
09047E700	ORD SP AMM DS CO	9045	270	MV9260	135.4	3.807	
09086G700	HHC AMMO BN DSGS	901	102	MV9570	6.250	1.438	
9227E500	ORD GM GS CO	9066	325	MV9277	19.95	4.582	
10407G600	QM AIR DEL CO	6204	76	MV9060	41.40	1.072	
10407G600	QM AIR DEL CO	5203	76	MV9060	41.40	1.072	
10458G600	QM PET SP CO FWD	6007	306	MV9654	24.20	4.315	
10476G600	HHC PET SPLY CO	611	84	MV9654	6.030	1.184	
11086E100	HHC SIG CBT AREA	706	141	MV7783	5.200	1.988	
11087E100	SIG CBT AREA CO	706A	174	MV7783	2.300	2.453	
11087E100	SIG CBT AREA CO	706B	174	MV8070	2.300	2.453	
11087E100	SIG CBT AREA CO	706D	174	MV8252	2.300	2.453	
11087E100	SIG CBT AREA CO	706C	174	MV9572	2.300	2.453	
11147E400	SIG SM HQ OP CO	739	126	MV7788	1.150	1.777	
12017G600	SPEC SERVICE CO	3266	42	MV7888	.0000	.5922	
12057E400	REPLACEMENT CO	3069	27	MV7471	.9500	.3807	
12067E520	PERSONNEL SVC CO	3358	74	MV7788	8.450	1.043	
12510G600	DATA PRCSNG UNIT	2422	156	MV7788	.0000	2.200	
12605G720	ARMY POSTAL UNIT	3190	37	MV6461	.0000	.5217	
19056G700	HH DET MP BN	231	59	MV7689	5.350	.8319	
19057G700	MP COMPANY	275	186	MV7689	11.00	2.623	
19057G700	MP COMPANY	276	186	MV6855	11.00	2.623	

RAC

Table C-1 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
20017E300	MIL HISTORY DET	2226	2	NV1180	.0000	.0000	
29102F500	HHC GEN SPT GP	14	142	MV7961	6.900	2.002	
29114G600	FLD SVC GS COFWD	2225	226	MV9482	10.40	3.215	
29118G600	GEN SUP SUPT CO	2447	264	MV8556	11.00	3.722	
29118G600	GEN SUP SUPT CO	2245	264	MV8563	11.00	3.722	
29119G600	REP PARTS GS CO	2291	274	MV7665	22.55	3.863	
29119G600	REP PARTS GS CO	2292	274	MV7738	22.55	3.863	
29126G700	HHC SUP GS BN	249	100	MV8556	6.350	1.410	
29126G700	HHC SUP GS BN	248	100	MV8868	6.350	1.410	
29127G600	HVY MTL GS CO	2231	200	MV6763	22.35	2.820	
29127G600	HVY MTL GS CO	2233	200	MV8538	22.35	2.820	
29134G600	L EQPMT GS ME CO	2083	276	MV7551	21.65	3.892	
29136G700	HH DET ME GS BN	203	63	MV7551	2.400	.8883	
29136G700	HH DET ME GS BN	216	63	MV8253	2.400	.8883	
29136G700	HH DET ME GS BN	215	63	MV8571	2.400	.8883	
29137G700	HV EQ GS MNT CO	2110	298	MV5753	5.300	4.202	
29137G700	HV EQ GS MNT CO	2111	298	MV6763	5.300	4.202	
29137G700	HV EQ GS MNT CO	2109	298	MV8856	5.300	4.202	
29139F500	COL CLS SAL CO	2142	216	MV6856	14.95	3.046	
29206F500	HQ MN SPT CO	2022	305	MV8253	16.50	4.300	
29206F500	HQ MN SPT CO	2021	305	MV8571	16.50	4.300	
29207F500	LT MAINT DS CO	2053	214	MV7381	2.900	3.017	
29207F500	LT MAINT DS CO	2052	214	MV8590	2.900	3.017	
29217G700	S+S CO S+S BN DS	2195	303	MV9060	12.95	4.272	
32057F410	ASA SPT CO DIV	293	231	MV9745	1.450	3.257	
32057F410	ASA SPT CO DIV	292	231	NV1180	1.450	3.257	
44012E400	HHB ADA GP	404	79	MV7571	5.500	1.114	
44235G620	HAWK BN	457	825	MV7283	26.85	4.610	
44235G620	HAWK BN	464	825	MV8456	26.85	4.610	
44235G620	HAWK BN	467	825	MV8489	26.85	4.610	
54022T500	HHC SPT BDE	2	272	MV7788	4.650	3.835	
55018G620	TRANS MED TRK CO	4073	183	MV9654	1.450	2.580	
55018G620	TRANS MED TRK CO	4075	183	MV9654	1.450	2.580	
55019E410	TRANS CAR CO	4276	135	MV7789	13.00	1.904	
55028G600	TR HEAVY TRK CO	4213	155	MV7991	1.450	2.186	
55067G600	TRAN L MED TK CO	4243	202	MV6561	3.850	2.848	
55067G600	TRAN L MED TK CO	4242	202	MV7991	3.850	2.848	
55067G600	TRAN L MED TK CO	4244	202	MV9056	3.850	2.848	
55067G600	TRAN L MED TK CO	4241	202	MV9998	3.850	2.848	
55457G600	TR ACFT DS ST CO	4006	265	MV7058	7.200	3.737	
55457G600	TR ACFT DS ST CO	4005	265	MV7571	7.200	3.737	
55458G700	TR ACFT MTCE CO	4039	290	MV7579	13.60	4.089	

Table C-2

CARGO FLEET SIMULATION UNIT[1]
AND MISSION PAYLOAD INPUT

Exploitation Posture - Light Unit Move Payloads

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
01111T710	AVN AIR WPNS CO	196	189	MV9355	2.600	2.660	8.100
05035G600	ENGR COM BN	521	836	MV7374	18.85	5.440	.6600
5035G600	ENGR COM BN	514	836	MV8749	18.85	5.440	.6600
05035G600	ENGR COM BN	515	836	MV8858	18.85	5.440	.6600
05035G600	ENGR COM BN	508	836	MV9090	18.85	5.440	.6600
05035G600	ENGR COM BN	511	836	NA0202	18.85	5.440	.6600
05035G600	ENGR COM BN	513	836	NV0746	18.85	5.440	.6600
05052E600	HHC ENG CMBT GP	67	114	MV7244	10.50	1.607	.0000
05054G710	ENG LT EQ CO ABN	5085	212	MV7144	3.000	1.770	.0800
05054G710	ENG LT EQ CO ABN	5086	212	MV7144	3.000	1.770	.0800
05064T100	ENG ASLT BRDG CO	5072	205	MV9555	3.700	2.891	.0000
06415E300	8IN SP BN	620	618	MV9286	135.6	3.190	16.36
06415E300	8IN SP BN	621	618	MV9386	135.6	3.190	16.36
06415E300	8IN SP BN	618	618	NV0749	135.6	3.190	16.36
06415E300	8IN SP BN	612	618	NV1590	135.6	3.190	16.36
06415E300	8IN SP BN	613	618	NV1699	135.6	3.190	16.36
06425G600	155 T BN	654	563	NV2388	146.1	3.030	18.39
06425G600	155 T BN	653	563	NV1968	146.1	3.030	18.39
06435G700	175 SP BN	662	550	MV9157	97.20	3.050	16.89
06435G700	175 SP BN	664	550	MV9970	97.20	3.050	16.89
06435G700	175 SP BN	663	550	NV0039	97.20	3.050	16.89
06455G700	155 SP BN	634	506	NV0855	52.70	2.870	18.10
06455G700	155 SP BN	636	506	NV1395	52.70	2.870	18.10
06455G700	155 SP BN	632	506	NV1541	52.70	2.870	18.10
06455G700	155 SP BN	635	506	NV2297	52.70	2.870	18.10

1. Only those units are shown which have a change in payload due to the shift from attack to exploitation posture.

Table C-3

CARGO FLEET SIMULATION UNIT
AND MISSION PAYLOAD INPUT

Attack Posture - Heavy Unit Move Payloads

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
01077G600	AIR MBL CO LIGHT	184	189	MV7058	4.000	2.730	
01077G600	AIR MBL CO LIGHT	182	189	MV7173	4.000	2.730	
01111T710	AVN AIR WPNS CO	196	189	MV9355	4.000	2.660	13.50
01128T600	AVN AIR SURVL CO	139	183	MV7671	20.00	2.580	
01252G600	HHC AVN GP	102	76	MV8749	.0000	1.072	
01256G600	HHC AVN BN	114	77	MV7173	8.500	1.086	
01256G600	HHC AVN BN	115	77	MV7551	8.500	1.086	
01258G600	AVN MED HEL CO	159	239	MV7058	4.000	4.800	
01258G600	AVN MED HEL CO	160	239	MV7173	4.000	4.800	
03267G600	CML SMOKE GEN CO	324	147	NV1180	52.00	2.073	
03267G600	CML SMOKE GEN CO	827	147	MV8749	52.00	2.073	
03267G600	CML SMOKE GEN CO	326	147	MV9845	52.00	2.073	
05035G600	ENGR COM BN	521	836	MV7374	33.50	5.440	2.740
05035G600	ENGR COM BN	514	836	MV8749	33.50	5.440	2.740
05035G600	ENGR COM BN	515	836	MV8858	33.50	5.440	2.740
05035G600	ENGR COM BN	508	836	MV9090	33.50	5.440	2.740
05035G600	ENGR COM BN	511	836	NA0202	33.50	5.440	2.740
05035G600	ENGR COM BN	513	836	NV0746	33.50	5.440	2.740
05052E600	HHC ENG CMBT GP	67	114	MV7244	13.75	1.607	.0000
05054G710	ENG LT EQ CO ABN	5085	212	MV7144	3.250	1.770	.3600
05054G710	ENG LT EQ CO ABN	5086	212	MV7144	3.250	1.770	.3600
05064T100	ENG ASLT BRDG CO	5072	205	MV9555	3.000	2.891	.0000
05064T100	ENG ASLT BRDG CO	5073	205	MV7787	3.000	2.891	
05077E000	ENG PANEL BRG CO	5039	129	MV9545	.7500	1.819	
05077E000	ENG PANEL BRG CO	5038	129	NV0746	.7500	1.819	
05078G600	ENG FLT BDG CO	5058	234	MV9545	4.000	3.299	
05124G600	ENG DUMP TRK CO	5009	114	MV7742	2.500	1.607	
05327G600	ENG TOPO CO	5001	143	MV7960	18.00	2.016	
06401G600	HHB FA GROUP	66	135	MV9246	13.00	1.904	
06401G600	HHB FA GROUP	65	135	NV0496	13.00	1.904	
06401G600	HHB FA GROUP	64	135	NV0673	13.00	1.904	
06415E300	81N SP BN	620	618	MV9286	130.5	3.190	97.47
06415E300	81N SP BN	621	618	MV9386	130.5	3.190	97.47
06415E300	81N SP BN	618	618	NV0749	130.5	3.190	97.47
06415E300	81N SP BN	612	618	NV1590	130.5	3.190	97.47
06415E300	81N SP BN	613	618	NV1699	130.5	3.190	97.47
06425G600	155 T BN	654	563	NV2388	161.5	3.030	103.7
06425G600	155 T BN	653	563	NV1968	161.5	3.030	103.7
06435G700	175 SP BN	662	550	MV9157	140.0	3.050	105.7
06435G700	175 SP BN	664	550	MV9970	140.0	3.050	105.7
06435G700	175 SP BN	663	550	NV0039	140.0	3.050	105.7

Table C-3 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
06455G700	155 SP BN	634	506	NV0855	67.50	2.870	102.5
06455G700	155 SP BN	636	506	NV1396	67.50	2.870	102.5
06455G700	155 SP BN	632	506	NV1541	67.50	2.870	102.5
06455G700	155 SP BN	635	506	NV2297	67.50	2.870	102.5
06501G600	HHB CORPS ARTY	2	211	MVB939	17.00	2.975	
06525E400	HJ BN	108	408	MV9697	38.00	5.753	
06525E400	HJ BN	107	408	NV2065	38.00	5.753	
06555G700	SGT BN	212	377	MV7481	40.50	5.316	
06575E600	TGT AQ BN	102	768	MVB999	25.50	10.83	
08122G600	HHD MED GP	83	37	MV7867	8.000	.5217	
08126G600	HQ HQ DET MED BN	803	39	MV6553	4.000	.5499	
08127G600	MED AMBL CO	8010	102	MV7565	2.500	1.43B	
08127G600	MED AMBL CO	8011	102	MVB848	2.500	1.438	
08128G600	MED CLRNG COMPY	8630	130	MV7565	5.500	1.833	
08137G600	MED AIR AMB CO	8001	202	MV7867	13.25	2.848	
08571E400	MOB AR SURG HOSP	8097	121	MV6553	9.500	1.706	
08571E400	MOB AR SURG HOSP	8096	121	MV9948	9.500	1.706	
08571E400	MOB AR SURG HOSP	8095	121	NV0687	9.500	1.706	
08581E400	EVACUATION HOSP	830	318	MV8848	8.000	4.484	
08581E400	EVACUATION HOSP	829	31B	MV9593	8.000	4.484	
09017G700	ORD AMMO DSGS CO	9011	315	MV9065	54.50	4.442	
09017G700	ORD AMMO DSGS CO	9009	315	MV9860	54.50	4.442	
09017G700	ORD AMMO DSGS CO	9008	315	MV9570	54.50	4.442	
09047E700	ORD SP AMM DS CO	9045	270	MV9260	142.0	3.807	
09086G700	HHC AMMO BN DSGS	901	102	MV9570	11.25	1.438	
09227E500	ORD GM GS CO	9066	325	MV9277	45.00	4.582	
10407G600	QM AIR DEL CO	6204	76	MV9060	59.50	1.072	
10407G600	QM AIR DEL CO	5203	76	MV9060	59.50	1.072	
10458G600	QM PET SP CO FWD	6007	306	MV9654	28.00	4.315	
10476G600	HHC PET SPLY CO	611	84	MV9654	10.00	1.184	
11086E100	HHC SIG CBT AREA	706	141	MV7783	11.00	1.988	
11087E100	SIG CBT AREA CO	706A	174	MV7783	3.000	2.453	
11087E100	SIG CBT AREA CO	706B	174	MV8070	3.000	2.453	
11087E100	SIG CBT AREA CO	706D	174	MV8252	3.000	2.453	
11087E100	SIG CBT AREA CO	706C	174	MV9572	3.000	2.453	
11147E400	SIG SM HQ OP CO	739	126	MV7788	1.500	1.777	
12017G600	SPEC SERVICE CO	3286	42	MV7888	.0000	.5922	
12057E400	REPLACEMENT CO	3069	27	MV7471	.7500	.3807	
12067E520	PERSONNEL SVC CO	3358	74	MV7788	9.500	1.043	
12510G600	DATA PRCSNG UNIT	2422	156	MV7788	.0000	2.200	
12605G720	ARMY POSTAL UNIT	3190	37	MV6461	.0000	.5217	
19056G700	HQ DET MP BN	231	59	MV7689	7.000	.8319	
19057G700	MP COMPANY	275	186	MV7689	10.00	2.623	
19057G700	MP COMPANY	276	186	MV8855	10.00	2.623	
20017E300	MIL HISTORY DET	2226	2	NV1180	.0000	.0000	

Table C-3 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Ammo pyld
29102F500	HHC GEN SPT GP	14	142	MV7961	9.000	2.002	
29114G600	FLD SVC GS COFWD	2225	228	MV9482	19.00	3.215	
29118G600	GEN SUP SUPT CO	2447	264	MV8556	27.00	3.722	
29118G600	GEN SUP SUPT CO	2245	264	MV8563	27.00	3.722	
29119G600	REP PARTS GS CO	2291	274	MV7665	50.50	3.863	
29119G600	REP PARTS GS CO	2292	274	MV7738	50.50	3.863	
29126G700	HHC SUP GS BN	249	100	MV8556	12.50	1.410	
29126G700	HHC SUP GS BN	248	100	MV8868	12.50	1.410	
29127G600	HVY MTL GS CO	2231	200	MV6763	34.70	2.820	
29127G600	HVY MTL GS CO	2233	200	MV8538	34.70	2.820	
29134G600	L EQPMT GS ME CO	2083	276	MV7551	41.20	3.892	
29136G700	HH DET ME GS BN	203	63	MV7551	4.750	.8883	
29136G700	HH DET ME GS BN	216	63	MV8253	4.750	.8883	
29136G700	HH DET ME GS BN	215	63	MV8571	4.750	.8883	
29137G700	HV EQ GS MNT CO	2110	298	MV5753	10.50	4.202	
29137G700	HV EQ GS MNT CO	2111	298	MV6763	10.50	4.202	
29137G700	HV EQ GS MNT CO	2109	298	MV8856	10.50	4.202	
29139F500	COL CLS SAL CO	2142	216	MV8856	34.00	3.046	
29206F500	HQ MN SPT CO	2022	305	MV8253	40.50	4.300	
29206F500	HQ MN SPT CO	2021	305	MV8571	40.50	4.300	
29207F500	LT MAINT DS CO	2053	214	MV7381	8.000	3.017	
29207F500	LT MAINT DS CO	2052	214	MV8590	8.000	3.017	
29217G700	S+S CO S+S BN DS	2195	303	MV9060	27.50	4.272	
32057F410	ASA SPT CO DIV	293	231	MV9745	2.500	3.257	
32057F410	ASA SPT CO DIV	292	231	NV1180	2.500	3.257	
44012E400	HHB ADA GP	404	79	MV7571	13.50	1.114	
44235G620	HAWK BN	457	825	MV7283	52.50	4.610	
44235G620	HAWK BN	464	825	MV8456	52.50	4.610	
44235G620	HAWK BN	467	825	MV8489	52.50	4.610	
54022T500	HHC SPT BDE	2	272	MV7788	5.500	3.835	
55018G620	TRANS MED TRK CO	4073	183	MV9654	4.000	2.580	
55018G620	TRANS MED TRK CO	4075	183	MV9654	4.000	2.580	
55019E410	TRANS CAR CO	4276	135	MV7789	15.00	1.904	
55028G600	TR HEAVY TRK CO	4213	155	MV7991	4.000	2.186	
55067G600	TRAN L MED TK CO	4243	202	MV6561	4.000	2.848	
55067G600	TRAN L MED TK CO	4242	202	MV7991	4.000	2.848	
55067G600	TRAN L MED TK CO	4244	202	MV9056	4.000	2.848	
55067G600	TRAN L MED TK CO	4241	202	MV9998	4.000	2.848	
55457G600	TR ACFT DS ST CO	4006	265	MV7058	11.50	3.737	
55457G600	TR ACFT DS ST CO	4005	265	MV7571	11.50	3.737	
55458G700	TR ACFT MTCE CO	4039	290	MV7579	32.50	4.089	

Table C-4

CARGO FLEET SIMULATION INPUT AND MISSION PAYLOAD INPUT[1]

Exploitation Posture - Heavy Unit Move Payloads

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit move pyld	Cargo pyld	Anno pyld
01111T710	AVN AIR WPNS CO	196	189	MV9355	4.000	2.660	8.100
05035G600	ENGR COM BN	521	836	MV7374	33.50	5.440	.6600
05035G600	ENGR COM BN	514	836	MV8749	33.50	5.440	.6600
05035G600	ENGR COM BN	515	836	MV8858	33.50	5.440	.6600
05035G600	ENGR COM BN	508	836	MV9090	33.50	5.440	.6600
05035G600	ENGR COM BN	511	836	NA0202	33.50	5.440	.6600
05035G600	ENGR COM BN	513	836	NV0746	33.50	5.440	.6600
05052E600	HHC ENG CMBT GP	67	114	MV7244	13.75	1.607	.0000
05054G710	ENG LT EQ CO ABN	5085	212	MV7144	3.250	1.770	.0800
05054G710	ENG LT EQ CO ABN	5086	212	MV7144	3.250	1.770	.0800
05064T100	ENG ASLT BRDG CO	5072	205	MV9555	3.000	2.891	.0000
06415E300	8IN SP BN	620	618	MV9286	130.5	3.190	16.36
06415E300	8IN SP BN	621	618	MV9386	130.5	3.190	16.36
06415E300	8IN SP BN	618	618	NV0749	130.5	3.190	16.36
06415E300	8IN SP BN	612	618	NV1590	130.5	3.190	16.36
06415E300	8IN SP BN	613	618	NV1699	130.5	3.190	16.35
06425G600	155 T BN	654	563	NV2388	161.5	3.030	18.39
06425G600	155 T BN	653	563	NV1968	161.5	3.030	18.39
06435G700	175 SP BN	662	550	MV9157	140.0	3.050	16.89
06435G700	175 SP BN	664	550	MV9970	140.0	3.050	16.89
06435G700	175 SP BN	663	550	NV0039	140.0	3.050	16.89
06455G700	155 SP BN	634	506	NV0855	67.50	2.870	18.10
06455G700	155 SP BN	636	506	NV1396	67.50	2.870	18.10
06455G700	155 SP BN	632	506	NV1541	67.50	2.870	18.10
06455G700	155 SP BN	635	506	NV2297	67.50	2.870	18.10

1. Only those units are shown which have a change in payload due to the shift from attack to exploitation posture.

Table C-5

TANKER FLEET SIMULATION UNIT AND MISSION PAYLOAD INPUT

Attack and Exploitation Posture

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Bulk fuel payload Attack posture	Exploit. posture
01077G600	AIR MBL CO LIGHT	184	189	MV7058	51.66	51.89
01077G600	AIR MBL CO LIGHT	182	189	MV7173	51.69	51.89
01111T710	AVN AIR WPNS CO	196	189	MV9355	42.50	18.50
01128T600	AVN AIR SURVL CO	139	183	MV7671	52.17	52.63
01252G600	HHC AVN GP	102	76	MV8749	1.961	1.961
01256G600	HHC AVN BN	114	77	MV7173	1.987	1.987
01256G600	HHC AVN BN	115	77	MV7551	1.987	1.987
01258G600	AVN MED HEL CO	159	239	MV7058	97.96	97.92
01258G600	AVN MED HEL CO	160	239	MV7173	97.96	97.92
03267G600	CML SMOKE GEN CO	324	147	NV1180	3.793	3.793
03267G600	CML SMOKE GEN CO	827	147	MV8749	3.793	3.793
03267G600	CML SMOKE GEN CO	326	147	MV9845	3.793	3.793
05035G600	ENGR COM BN	521	836	MV7374	30.41	45.61
05035G600	ENGR COM BN	514	836	MV8749	30.41	45.61
05035G600	ENGR COM BN	515	836	MV8858	30.41	45.61
05035G600	ENGR COM BN	508	836	MV9090	30.41	45.61
05035G600	ENGR COM BN	511	836	NA0202	30.41	45.61
05035G600	ENGR COM BN	513	836	NV0746	30.41	45.61
05052E600	HHC ENG CMBT GP	67	114	MV7244	2.941	2.941
05054G710	ENG LT EQ CO ABN	5085	212	MV7144	17.53	26.29
05054G710	ENG LT EQ CO ABN	5086	212	MV7144	17.53	26.29
05064T100	ENG ASLT BRDG CO	5072	205	MV9555	5.289	5.289
05064T100	ENG ASLT BRDG CO	5073	205	MV7787	5.289	5.289
05077E000	ENG PANEL BRG CO	5039	129	MV9545	3.328	3.328
05077E000	ENG PANEL BRG CO	5038	129	NV0746	3.328	3.328
05078G600	ENG FLT BDG CO	5058	234	MV9545	6.037	6.037
05124G600	ENG DUMP TRK CO	5009	114	MV7742	2.941	2.941
05327G600	ENG TOPO CO	5001	143	MV7960	3.689	3.689
06401G600	HHB FA GROUP	66	135	MV9246	3.483	3.483
06401G600	HHB FA GROUP	65	135	NV0496	3.483	3.483
06401G600	HHB FA GROUP	64	135	NV0673	3.483	3.483
06415E300	8IN SP BN	620	618	MV9286	8.270	7.100
06415E300	8IN SP BN	621	618	MV9386	8.270	7.100
06415E300	8IN SP BN	618	618	NV0749	8.270	7.100
06415E300	8IN SP BN	612	618	NV1590	8.270	7.100
06415E300	8IN SP BN	613	618	NV1699	8.270	7.100
06425G600	155 T BN	654	563	NV2388	4.580	6.710
06425G600	155 T BN	653	563	NV1966	4.580	6.710
06435G700	175 SP BN	662	550	MV9157	8.320	12.10
06435G700	175 SP BN	664	550	MV9970	8.320	12.10
06435G700	175 SP BN	663	550	NV0039	8.320	12.10

Table C-5 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Bulk fuel payload Attack posture	Bulk fuel payload Exploit. posture
06455G700	155 SP BN	634	506	NV0855	6.270	9.400
06455G700	155 SP BN	636	506	NV1396	6.270	9.400
06455G700	155 SP BN	632	506	NV1541	6.270	9.400
06455G700	155 SP BN	635	506	NV2297	6.270	9.400
06501G600	HHB CORPS ARTY	2	211	MV8939	5.444	5.444
06525E400	HJ BN	108	408	MV9697	10.53	10.53
06525E400	HJ BN	107	408	NV2065	10.53	10.53
06555G700	SGT BN	212	377	MV7481	9.727	9.727
06575E600	TGT AQ BN	102	768	MV8999	19.81	19.81
08122G600	HHD MED GP	83	37	MV7867	.9546	.9546
08126G600	HQ HC DET MED BN	803	39	MV6553	1.006	1.006
08127G600	MED AMBL CO	8010	102	MV7565	2.632	2.632
08127G600	MED AMBL CO	8011	102	MV8848	2.632	2.632
08128G600	MED C RNG COMPY	8630	130	MV7565	3.354	3.354
08137G600	MED AIR AMB CO	8001	202	MV7867	52.63	52.63
08571E400	MOB AR SURG HOSP	8097	121	MV6553	3.122	3.122
08571E400	MOB AR SURG HOSP	8096	121	MV9948	3.122	3.122
08571E400	MOB AR SURG HOSP	8095	121	NV0687	3.122	3.122
08581E400	EVACUATION HOSP	830	318	MV8848	8.204	8.204
08581E400	EVACUATION HOSP	829	318	MV9593	8.204	8.204
09017G700	ORD AMMO DSGS CO	9011	315	MV9065	8.127	8.127
09017G700	ORD AMMO DSGS CO	9009	315	MV9860	8.127	8.127
09017G700	ORD AMMO DSGS CO	9008	315	MV9570	8.127	8.127
09047E700	ORD SP AMM DS CO	9045	270	MV9260	6.966	6.966
09086G700	HHC AMMO BN DSGS	901	102	MV9570	2.632	2.632
09227E500	ORD GM GS CO	9066	325	MV9277	8.385	8.385
10407G600	QM AIR DEL CO	6204	76	MV9060	1.961	1.961
10407G600	QM AIR DEL CO	5203	76	MV9060	1.961	1.961
10458G600	QM PET SP CO FWD	6007	306	MV9654	.0000	.0000
10476G600	HHC PET SPLY CO	611	84	MV9654	2.167	2.167
11086E100	HHC SIG CBT AREA	706	141	MV7783	3.638	3.638
11087E100	SIG CBT AREA CO	706A	174	MV7783	4.489	4.489
11087E100	SIG CBT AREA CO	706B	174	MV8070	4.489	4.489
11087E100	SIG CBT AREA CO	706D	174	MV8252	4.489	4.489
11087E100	SIG CBT AREA CO	706C	174	MV9572	4.489	4.489
11147E400	SIG SA HQ CP CO	739	126	MV7788	3.251	3.251
12017G600	SPEC SERVICE CO	3286	42	MV7888	1.084	1.084
12057E400	REPLACEMENT CO	3069	27	MV7471	.6966	.6966
12067E520	PERSONNEL SVC CO	3358	74	MV7788	1.909	1.909
12510G600	DATA PRCSNG UNIT	2422	156	MV7788	4.025	4.025
12605G720	ARMY POSTAL UNIT	3190	37	MV6461	.9546	.9546
19056G700	HH DET MP BN	231	59	MV7689	1.522	1.522
19057G700	MP COMPANY	275	186	MV7689	4.799	4.799
19057G700	MP COMPANY	276	186	MV6855	4.799	4.799
20017E300	MIL HISTORY DET	2226	2	NV1180	.0000	.0000
29102F500	HHC GEN SPT GP	14	142	MV7961	3.604	3.604
29114G600	FLD SVC GS COFWD	2225	228	MV9482	5.882	5.882

Table C-5 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Bulk fuel payload: Attack posture	Bulk fuel payload: Exploit. posture
29118G600	GEN SUP SUPT CO	2447	264	MV8555	6.811	6.811
29118G600	GEN SUP SUPT CO	2245	264	MV8563	6.811	6.811
29119G600	REP PARTS GS CO	2291	274	MV7665	7.069	7.069
29119G600	REP PARTS GS CO	2292	274	MV7738	7.069	7.069
29126G700	HHC SUP GS BN	249	100	MV8556	2.580	2.580
29126G700	HHC SUP GS BN	248	100	MV8868	2.580	2.580
29127G600	HVY MTL GS CO	2231	200	MV6763	5.160	5.160
29127G600	HVY MTL GS CO	2233	200	MV6538	5.160	5.160
29134G600	L EQPMT GS ME CO	2083	276	MV7551	7.121	7.121
29136G700	HH DET ME GS BN	203	63	MV7551	1.625	1.625
29136G700	HH DET ME GS BN	216	63	MV8253	1.625	1.625
29136G700	HH DET ME GS BN	215	63	MV8571	1.625	1.625
29137G700	HV EQ GS MNT CO	2110	298	MV5753	7.688	7.688
29137G700	HV EQ GS MNT CO	2111	298	MV6763	7.688	7.688
29137G700	HV EQ GS MNT CO	2109	298	MV8856	7.688	7.688
29139F500	COL CLS SAL CO	2142	216	MV8856	5.573	5.573
29206F500	HQ MN SPT CO	2022	305	MV8253	7.869	7.869
29206F500	HQ MN SPT CO	2021	305	MV8571	7.869	7.869
29207F500	LT MAINT DS CO	2053	214	MV7381	5.521	5.521
29207F500	LT MAINT DS CO	2052	214	MV8590	5.521	5.521
29217G700	S+S CO S+S BN DS	2195	303	MV9060	7.817	7.817
32057F410	ASA SPT CO DIV	293	231	MV9745	5.960	5.960
32057F410	ASA SPT CO DIV	292	231	NV1180	5.960	5.960
44012E400	HHB ADA GP	404	79	MV7571	2.038	2.038
44235G620	HAWK BN	457	825	MV7283	14.74	13.00
44235G620	HAWK BN	464	825	MV8456	14.74	13.00
44235G620	HAWK BN	467	825	MV8489	14.74	13.00
54022T500	HHC SPT BDE	2	272	MV7788	7.018	7.018
55018G620	TRANS MED TRK CO	4073	183	MV9654	4.721	4.721
55018G620	TRANS MED TRK CO	4075	183	MV9654	4.721	4.721
55019E410	TRANS CAR CO	4276	135	MV7789	3.483	3.483
55028G600	TR HEAVY TRK CO	4213	155	MV7991	3.999	3.999
55067G600	TRAN L MED TK CO	4243	202	MV8561	5.212	5.212
55067G600	TRAN L MED TK CO	4242	202	MV7991	5.212	5.212
55067G600	TRAN L MED TK CO	4244	202	MV9056	5.212	5.212
55067G600	TRAN L MED TK CO	4241	202	MV9998	5.212	5.212
55457G600	TR ACFT DS ST CO	4006	265	MV7058	6.837	6.837
55457G600	TR ACFT DS ST CO	4005	265	MV7571	6.837	6.837
55458G700	TR ACFT MTCE CO	4039	290	MV7579	7.482	7.482

Table C-6

CONTAINER FLEET SIMULATION UNIT
AND MISSION PAYLOAD INPUT

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit container payload
01077G600	AIR MBL CO LIGHT	184	189	MV7058	5.000
01077G600	AIR MBL CO LIGHT	182	189	MV7173	5.000
01111T710	AVN AIR WPNS CO	196	189	MV9355	0.000
01128T600	AVN AIR SURVL CO	139	183	MV7671	10.00
01252G600	HHC AVN GP	102	76	MV8749	0.000
01256G600	HHC AVN BN	114	77	MV7173	0.000
01256G600	HHC AVN BN	115	77	MV7551	0.000
01258G600	AVN MED HEL CO	159	239	MV7058	10.00
01258G600	AVN MED HEL CO	160	239	MV7173	10.00
03267G600	CML SMOKE GEN CO	324	147	NV1180	0.000
03267G600	CML SMOKE GEN CO	827	147	MV8749	0.000
03267G600	CML SMOKE GEN CO	326	147	MV9845	0.000
05035G600	ENGR COM BN	521	836	MV7374	5.000
05035G600	ENGR COM BN	514	836	MV8749	5.000
05035G600	ENGR COM BN	515	836	MV8858	5.000
05035G600	ENGR COM BN	508	836	MV9090	5.000
05035G600	ENGR COM BN	511	836	NA0202	5.000
05035G600	ENGR COM BN	513	836	NV0746	5.000
05052E600	HHC ENG CMBT GP	67	114	MV7244	0.000
05054G710	ENG LT EQ CO ABN	5085	212	MV7144	10.00
05054G710	ENG LT EQ CO ABN	5086	212	MV7144	10.00
05064T100	ENG ASLT BRDG CO	5072	205	MV9555	5.000
05064T100	ENG ASLT BRDG CO	5073	205	MV7787	5.000
05077E000	ENG PANEL BRG CO	5039	129	MV9545	0.000
05077F000	ENG PANEL BRG CO	5038	129	NV0746	0.000
05078G600	ENG FLT BDG CO	5058	234	MV9545	0.000
05124G600	ENG DUMP TRK CO	5009	114	MV7742	5.000
05327G600	ENG TOPO CO	5001	143	MV7960	40.00
06401G600	HHB FA GROUP	66	135	MV9246	0.000
06401G600	HHB FA GROUP	65	135	NV0496	0.000
06401G600	HHB FA GROUP	64	135	NV0673	0.000
06415F300	81N SP BN	620	618	MV9286	17.50
06415E300	81N SP BN	621	618	MV9386	17.50
06415F300	81N SP BN	618	618	NV0749	17.50
06415F300	81N SP BN	612	618	NV1590	17.50
06415F300	81N SP BN	613	618	NV1699	17.50
06425G600	155 T BN	654	563	NV2388	2.500
06425G600	155 T BN	653	563	NV1968	2.500
06435G700	175 SP BN	662	550	MV9157	2.500
06435G700	175 SP BN	664	550	MV9970	2.500
06435G700	175 SP BN	663	550	NV0039	2.500

Table C-6 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit container payload
06455G700	155 SP BN	634	506	NV0855	0.000
06455G700	155 SP BN	636	506	NV1396	0.000
06455G700	155 SP BN	632	506	NV1541	0.000
06455G700	155 SP BN	635	506	NV2297	0.000
06501G600	HHB CORPS ARTY	2	211	MV8939	12.50
06525F400	HJ BN	108	408	MV9697	10.00
06525E400	HJ BN	107	408	NV2065	10.00
06555G700	SGT BN	212	377	MV7481	20.00
06575E600	TGT AQ BN	102	768	MV8999	47.50
08122G600	HHD MED GP	83	37	MV7867	0.000
08126G600	HQ HQ DET MED BN	803	39	MV6553	0.000
08127G600	MED AMBL CO	8010	102	MV7565	0.000
08127G600	MED AMBL CO	8011	102	MV8848	0.000
08128G600	MED CLRNG COMPY	8630	130	MV7565	0.000
08137G600	MED AIR AMB CO	8001	202	MV7867	2.500
08571E400	MOB AR SURG HOSP	8097	121	MV6553	0.000
08571E400	MOB AR SURG HOSP	8096	121	MV9948	0.000
08571F400	MOB AR SURG HOSP	8095	121	NV0687	0.000
08581F400	EVACUATION HOSP	830	318	MV8848	0.000
08581E400	EVACUATION HOSP	829	318	MV9593	0.000
09017G700	ORD AMMO DSGS CO	9011	315	MV9065	0.000
09017G700	ORD AMMO DSGS CO	9009	315	MV9860	0.000
09017G700	ORD AMMO DSGS CO	9008	315	MV9570	0.000
09047F700	ORD SP AMM DS CO	9045	270	MV9260	5.000
09086G700	HHC AMMO BN DSGS	901	102	MV9570	5.000
09227E500	ORD GM GS CO	9066	325	MV9277	32.50
10407G600	QM AIR DEL CO	6204	76	MV9060	0.000
10407G600	QM AIR DEL CO	5203	76	MV9060	0.000
10458G600	QM PET SP CO FWD	6007	306	MV9654	0.000
10476G600	HHC PET SPLY CO	611	84	MV9654	0.000
11086E100	HHC SIG CBT AREA	706	141	MV7783	40.00
11087F100	SIG CBT AREA CO	706A	174	MV7783	67.50
11087E100	SIG CBT AREA CO	706B	174	MV8070	67.50
11087F100	SIG CBT AREA CO	706D	174	MV8252	67.50
11087F100	SIG CBT AREA CO	706C	174	MV9572	67.50
11147F400	SIG SM HQ OP CO	739	126	MV7788	22.50
12017G600	SPEC SERVICE CO	3286	42	MV7888	35.00
12057E400	REPLACEMENT CO	3069	27	MV7471	0.000
12067F520	PERSONNEL SVC CO	3358	74	MV7788	0.000
12510G600	DATA PRCSNG UNIT	2422	156	MV7788	0.000
12605G720	ARMY POSTAL UNIT	3190	37	MV6461	2.500
19056G700	HH DET MP BN	231	59	MV7689	0.000
19057G700	MP COMPANY	275	186	MV7689	0.000
19057G700	MP COMPANY	276	186	MV8855	0.000

Table C-6 (continued)

SRC	Unit type	Unit I.D.	Unit pers	UTM grid coord	Unit container payload
20017F300	MIL HISTORY DET	2226	2	NV1180	0.000
29102F500	HHC GEN SPT GP	14	142	MV7961	2.500
29114G600	FLD SVC GS COFWD	2225	228	MV9482	0.000
29118G600	GEN SUP SUPT CO	2447	264	MV8556	0.000
29118G600	GEN SUP SUPT CO	2245	264	MV8563	0.000
29119G600	REP PARTS GS CO	2291	274	MV7665	0.000
29119G600	REP PARTS GS CO	2292	274	MV7738	0.000
29126G700	HHC SUP GS BN	249	100	MV8556	0.000
29126G700	HHC SUP GS BN	248	100	MV8868	0.000
29127G600	HVY MTL GS CO	2231	200	MV6763	0.000
29127G600	HVY MTL GS CO	2233	200	MV8538	0.000
29134G600	L EQPMT GS ME CO	2083	276	MV7551	20.00
29136G700	HH DET ME GS BN	203	63	MV7551	0.000
29136G700	HH DET ME GS BN	216	63	MV8253	0.000
29136G700	HH DET ME GS BN	215	63	MV8571	0.000
29137G700	HV EQ GS MNT CO	2110	298	MV5753	10.00
29137G700	HV EQ GS MNT CO	2111	298	MV6763	10.00
29137G700	HV EQ GS MNT CO	2109	298	MV8856	10.00
29139F500	COL CLS SAL CO	2142	216	MV8856	7.500
29206F500	HQ MN SPT CO	2022	305	MV8253	17.50
29206F500	HQ MN SPT CO	2021	305	MV8571	17.50
29207F500	LT MAINT DS CO	2053	214	MV7381	17.50
29207F500	LT MAINT DS CO	2052	214	MV8590	17.50
29217G700	S+S CO S+S BN DS	2195	303	MV9060	2.500
32057F410	ASA SPT CO DIV	293	231	MV9745	10.00
32057F410	ASA SPT CO DIV	292	231	NV1180	10.00
44012F400	HHB ADA GP	404	79	MV7571	5.000
44235G620	HAWK BN	457	825	MV7283	87.50
44235G620	HAWK BN	464	825	MV8456	87.50
44235G620	HAWK BN	467	825	MV8489	87.50
54022T500	HHC SPT BDE	2	272	MV7788	0.000
55018G620	TRANS MED TRK CO	4073	183	MV9654	0.000
55018G620	TRANS MED TRK CO	4075	183	MV9654	0.000
55019F410	TRANS CAR CO	4276	135	MV7789	0.000
55028G600	TR HEAVY TRK CO	4213	155	MV7991	0.000
55067G600	TRAN L MED TK CO	4243	202	MV6561	0.000
55067G600	TRAN L MED TK CO	4242	202	MV7991	0.000
55067G600	TRAN L MED TK CO	4244	202	MV9056	0.000
55067G600	TRAN L MED TK CO	4241	202	MV9998	0.000
55457G600	TR ACFT DS ST CO	4006	265	MV7058	2.500
55457G600	TR ACFT DS ST CO	4005	265	MV7571	2.500
55458G700	TR ACFT MTCE CO	4039	290	MV7579	5.000

Appendix D

SENSITIVITY ANALYSIS - CARGO FLEET SIMULATION

UNIT MOVE PAYLOADS

This appendix presents the results of several sensitivity analysis runs produced to test the effect of unit move payload assumptions on the vehicle fleet performance results as described in Chapter 3. The figures shown in the main body of the report are for unit move payloads comprising the sum of the individual vehicle payloads (at rated off-road capacity) of vehicles pooled from the units requiring unit move assistance. The figures shown here are for unit move payloads consisting of the sum of vehicle payloads from the REVAL WHEELS data on loads usually carried by the vehicles concerned. These unit move payloads as seen in Table C-1 are considerably lighter than those used in the standard cargo fleet simulations.

Figures D-1, D-2, and D-3 show mission dispatch delays and Figs. D-5, D-6, and D-7, mission completion times for the three basic mission types of the cargo fleet simulations. Mission completion time distributions aggregated over all mission types are given in Fig. D-4. As the figures show, the use of unit move payloads based on REVAL data would have indicated that the 40% pooled fleet and fleet remix A provided "equal" simulated fleet performance to the current fleet. Since these pooled fleet alternatives comprise fewer vehicles (and thus drivers) than those used for the cost comparisons shown in Chapter 3, the cost savings shown there are more conservative than those which would have resulted if the unit move payloads shown in this appendix had been used.

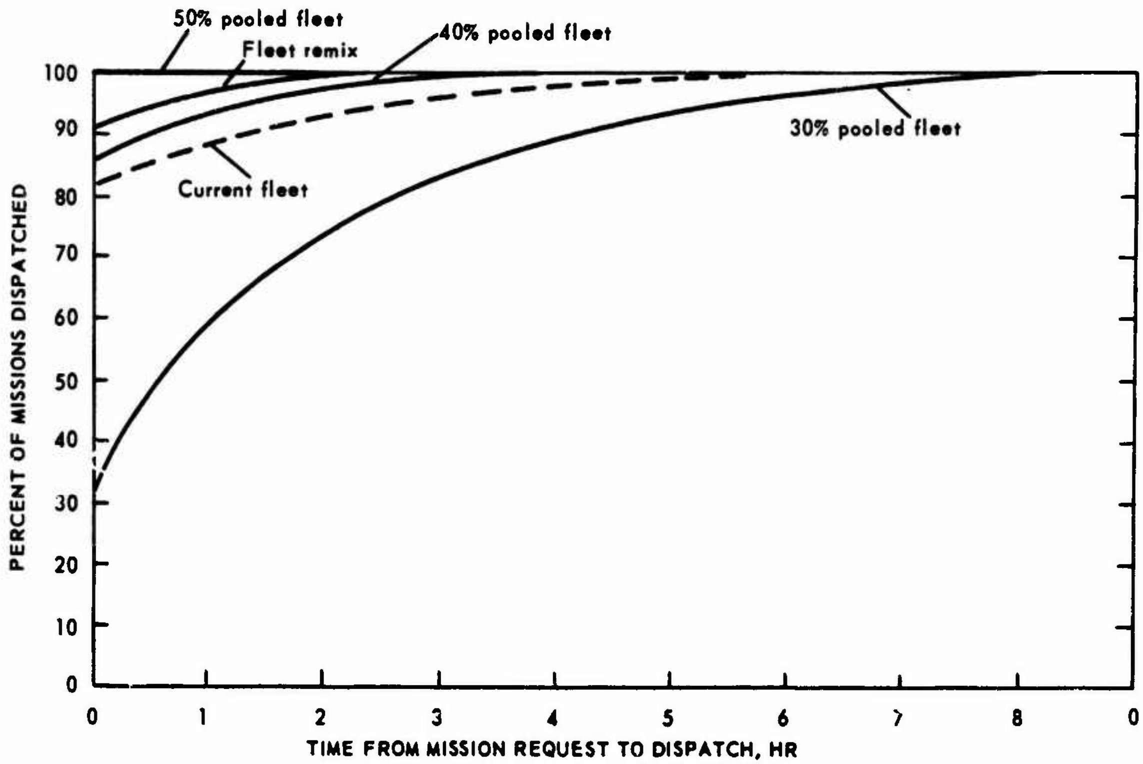


Fig. D-1—Cumulative Mission Dispatch Times, Ammunition Resupply Missions with Light Unit Move Payloads

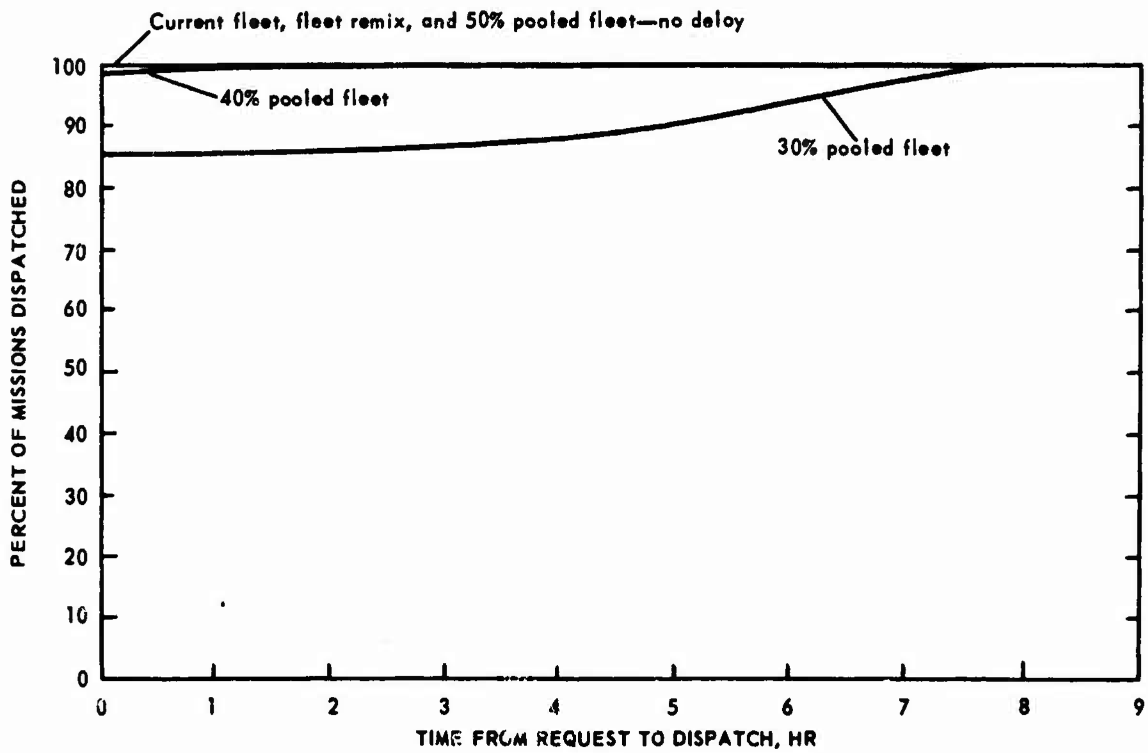


Fig. D-2—Cumulative Mission Dispatch Times, Unit Move Missions with Light Unit Move Payloads

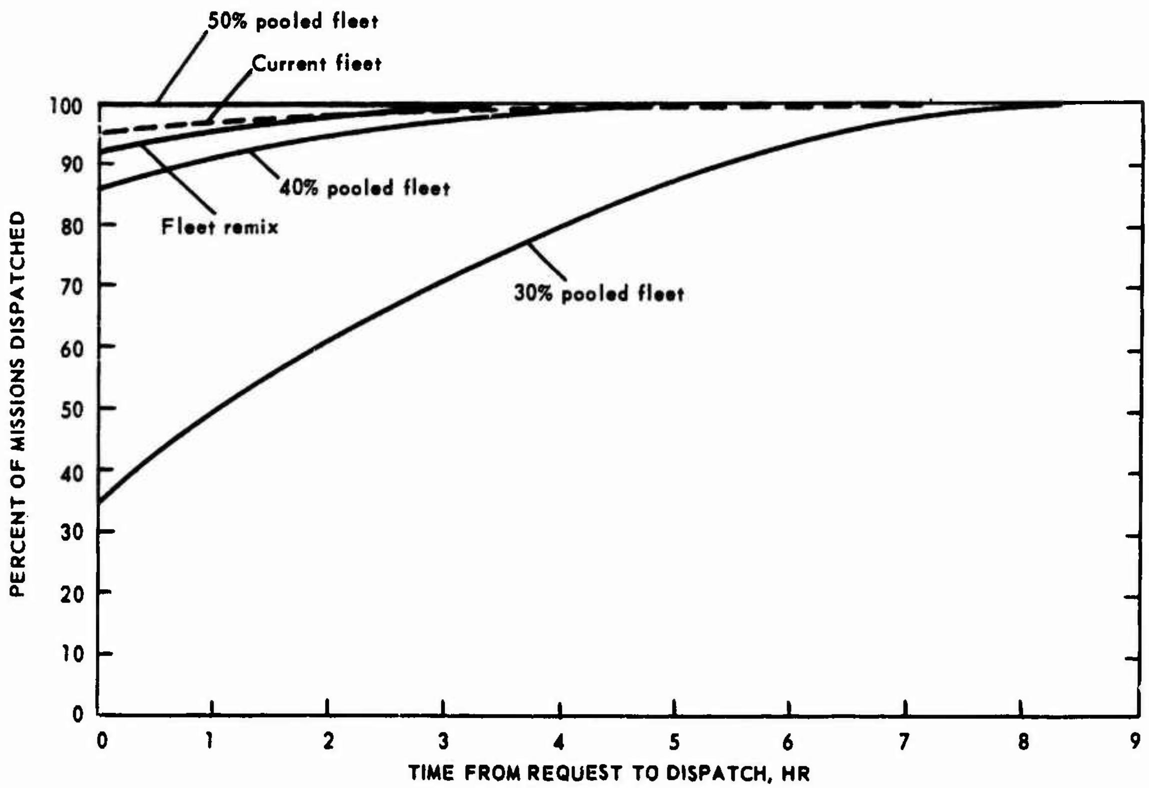


Fig. D-3—Cumulative Mission Dispatch Times, Other Cargo and Resupply Missions with Light Unit Move Payloads

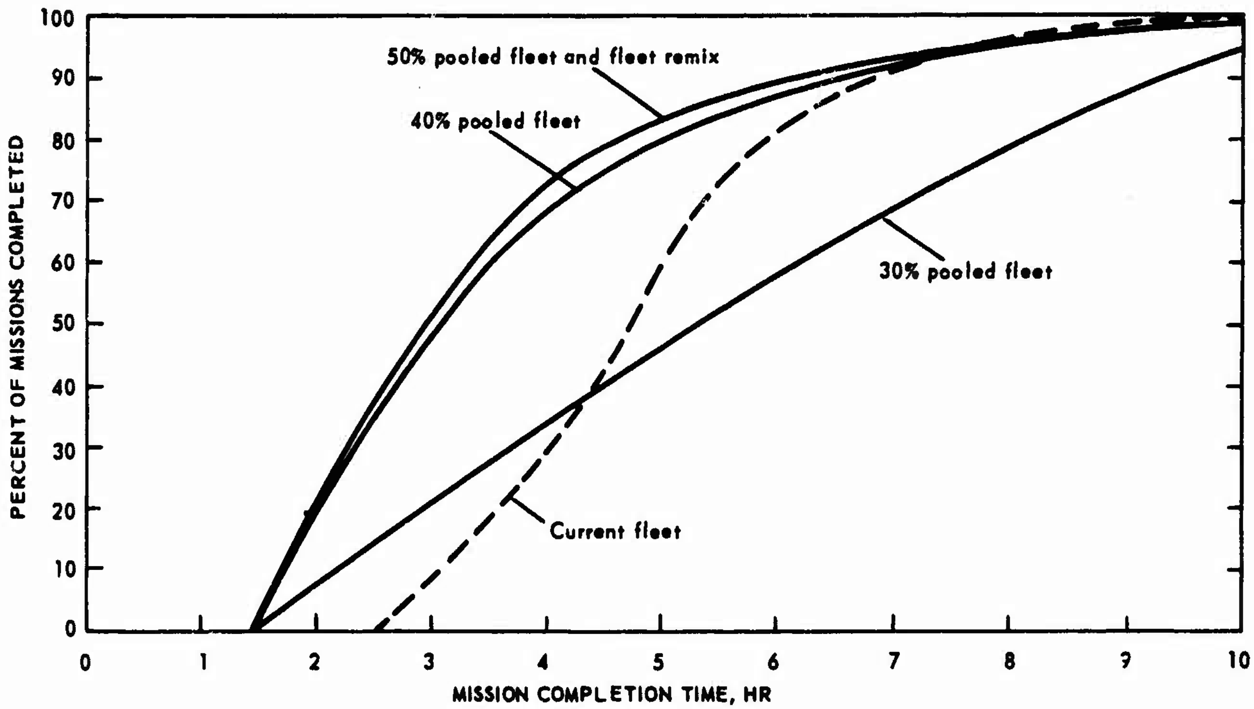


Fig. D-4—Cumulative Mission Completion Times, All Missions with Light Unit Move Payloads

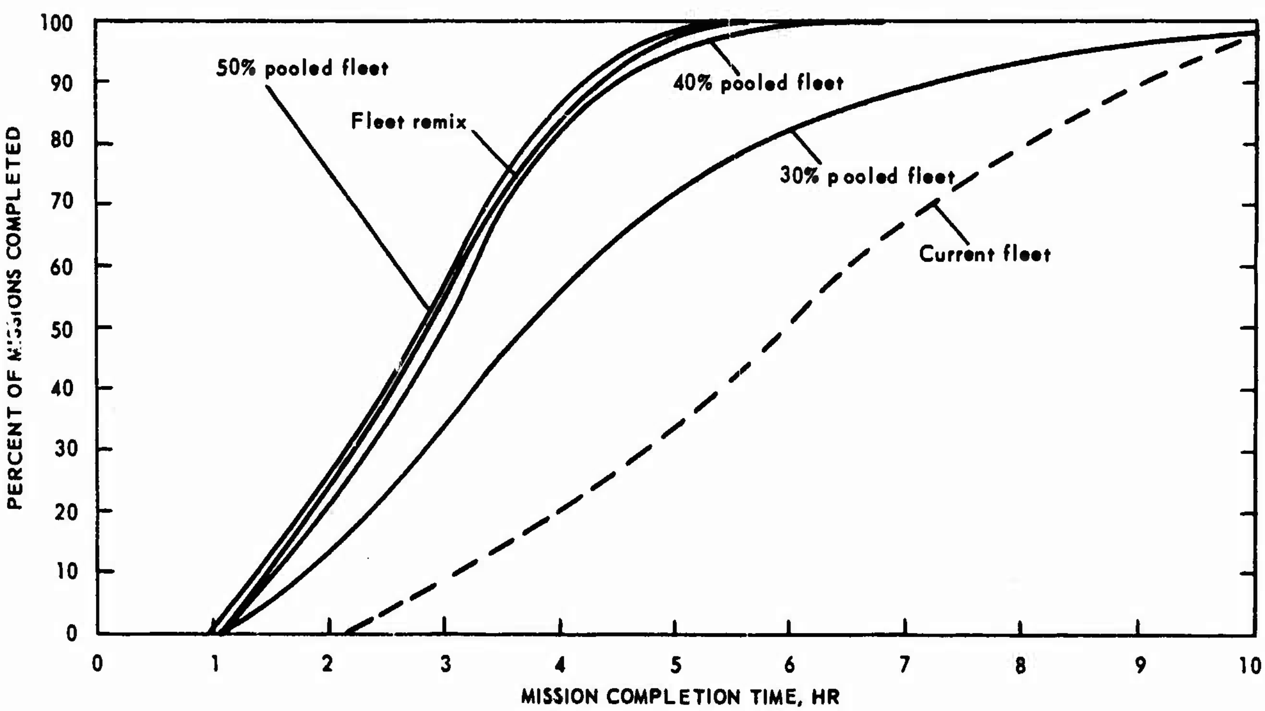


Fig. D-5—Cumulative Mission Completion Times, Ammunition Resupply with Light Unit Move Payloads

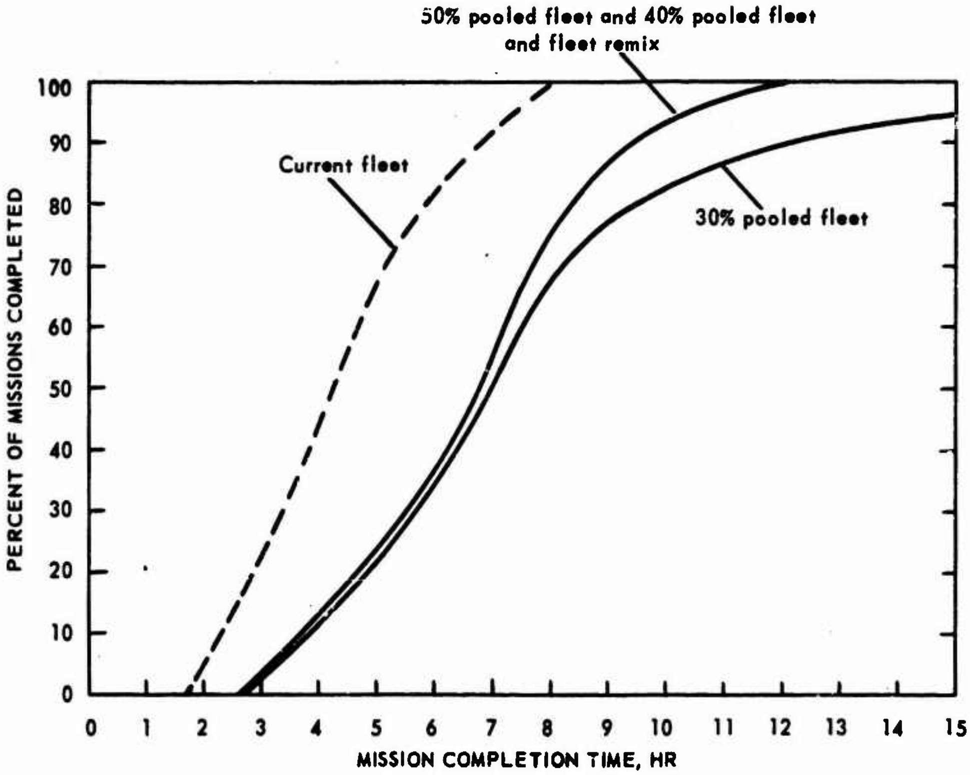


Fig. D-6—Cumulative Mission Completion Times, Unit Moves with Light Unit Move Payloads

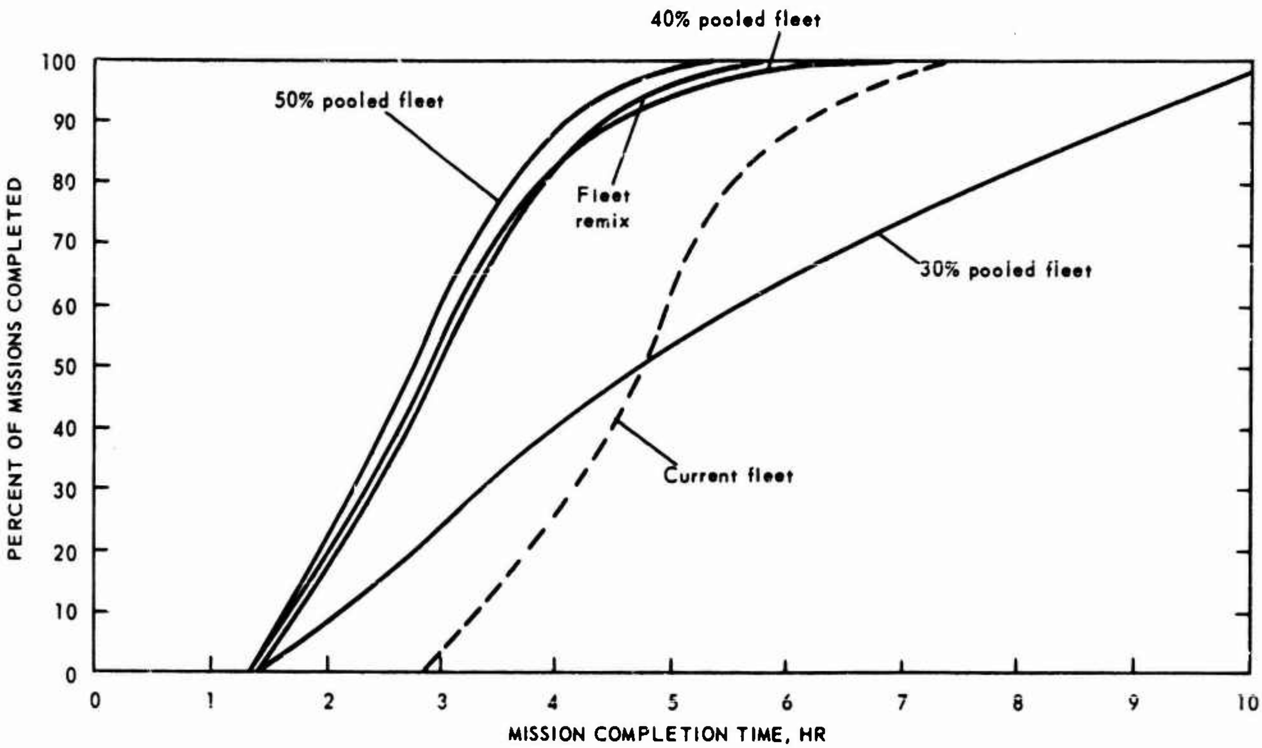


Fig. D-7—Cumulative Missian Completion Times, Other Carga Resupply with Light Unit Mave Payloads

REFERENCES

CITED REFERENCES

1. U.S. Army, ACSFOR, "REVAL WHEELS (Reevaluation of the Army Tactical Vehicle Program)," Mar. 1968, CONFIDENTIAL.

2. _____, Ft. Lee, Va., "LOGEX 71, An Interservice Logistical Exercise," May 1971.

3. _____, Command and General Staff College, "Organizational Data for the Army in the Field," RB 101-10-1, Mar. 1968.

4. DA, "Staff Officers Field Manual, Organizational, Technical, and Logistic Data," FM 101-10-1, Sep. 1969.

5. U.S. Army, CDC, "Army Logistics Support Concepts — Air Lines of Communication (U)," Short Title: LOGALOC II (U), Feb. 1968, SECRET.

6. _____, ACSFOR, "Armed Forces Planning Guide — Europe," Vol. I, Aug. 1970, SECRET.

7. Research Analysis Corporation, "Analysis of Opportunities for the Reduction of Tactical Vehicle Requirements Through Pooling," RAC-TP-420, April 1971.

8. _____, "Computerized QUICKGAMF: A Theater-Level Simulation," RAC-TP-266, Nov. 1967.

9. Operations Research Office, "Rates of Advance in Land Attack Against Unprepared Forces," ORO-TP-10, Aug. 1960.

10. U.S. Army, CDC, "Family of Army Vehicles—1985," Short Title: FAVS-85, In Progress.

RAC DISTRIBUTION LIST B

3 January 1972

Recipients of this document are indicated by ☒

	Address code	Agency	Number of copies
		DEPARTMENT OF DEFENSE	
☐	A2	Director of Defense Research and Engineering	1
☐	A3	Assistant Secretary of Defense, (International Security Affairs)	1
☒	A9	Assistant Secretary of Defense, (Systems Analysis)	2
☐	B2	Joint Chiefs of Staff	1
☒	B4	Studies Analysis Gaming Agency	1
☒	B5	Weapons Systems Evaluation Group	1
☒	C1	Advanced Research Projects Agency	1
☐	C2	Defense Nuclear Agency	1
☐	C3	National Security Agency	1
☐	C4	Defense Communications Agency	1
* ☒	C6	Defense Documentation Center	2
☐	C9	Defense Intelligence Agency	1
☒	D1	National War College	1
☒	D2	Industrial College of the Armed Forces	1
☒	D3	Armed Forces Staff College	1
		HEADQUARTERS, DEPARTMENT OF THE ARMY	
☒	E2	Office, Under Secretary of the Army (OR)	1
☒	E4	Assistant Secretary of the Army (R&D)	1
☒	E7	Deputy Chief of Staff for Personnel	1
☒	E8	Deputy Chief of Staff for Military Operations	2
☒	E9	Deputy Chief of Staff for Logistics	1
☒	E10	Assistant Chief of Staff, Intelligence	2
☒	E11	Directorate of Military Support	1
☒	E14	Comptroller	1
** ☒	E15	The Army Library, Attn: ASDIRS	1
☐	E16	Office of the Provost Marshal General	1
☒	E18	Office of the Surgeon General	1
☒	E19	Assistant Chief of Staff for Communications-Electronics	1
☐	E22	Office of Personnel Operations	1
☒	E23	Assistant Chief of Staff for Force Development	1
☒	E27	Chief of Research and Development	1
☒	E32	Office of Reserve Components	1
☒	E33	Assistant Vice Chief of Staff	4
		ARMIES	
☐	H2	First US Army	1
☐	H3	Third US Army	1
☐	H5	Fifth US Army	1
☐	H6	Sixth US Army	1
☐	H8	Eighth US Army	1
		UNIFIED COMMANDS	
☐	L5	Commander in Chief, Alaska (CINCAL)	1
☐	L6	Commander in Chief, Pacific (CINCPAC)	1
☐	L12	Commander in Chief, Europe (CINCEUCOM)	1
☐	L16	US Strike Command, MacDill Air Force Base (CINCSTRIKE)	1
		ARMY COMMANDS (CONUS)	
☐	J11	US Army Security Agency	1
☐	L1	US Army Air Defense Command	1
☒	L61	US Continental Army Command	2
☐	M19	US Army Strategic Communications Command	1
		ARMY COMMANDS (Overseas)	
☒	L8	US Army, Alaska	1
☒	L9	US Army Forces Southern Command	1
☒	L10	US Army, Europe and Seventh Army	1

* Required IAW AR 70-11 and AR 70-31.

** Normally required; exclusion must be justified by Sponsor (AR 1-28).

	Address code	Agency	Number of copies
☒	L11	US Army Pacific	1
☒	R11	US Army Concept Team, Vietnam	1
		ARMY MATERIEL COMMAND	
☒	L3	Hq US Army Materiel Command, Washington, D.C.	1
☐	I5	US Army Munitions Command, Edgewood Arsenal	1
☒	J4	US Army Armor and Engineer Board, Ft. Knox	1
☒	J5	US Army Field Artillery Board, Ft. Sill	1
☒	J6	US Army Aviation Test Board, Ft. Rucker	1
☒	J8	US Army Infantry Board, Ft. Benning	1
☐	M7	US Army Electronics Command, Ft. Monmouth	1
☒	M10	US Army Missile Command, Redstone Arsenal	1
☒	M13	US Army Munitions Command, Dover, N.J.	1
☒	M22	US Army Aviation Systems Command, St. Louis	1
☐	M24	US Army Weapons Command, Rock Island	1
☒	M25	US Army Mobility Equipment Command, St. Louis	1
☐	M26	Management Information Systems Directorate	1
☒	M29	USA Advanced Materiel Concepts Agency, Alexandria, Va.	1
☒	M30	US Army Army Tank-Automotive Command, Warren	1
☐	M32	US Army Test and Evaluations Command, Aberdeen Proving Ground	1
☐	R6	Dugway Proving Ground, Dugway	1
☐	R9	White Sands Missile Range, Las Cruces	1
☒	G25	Director, Army Materiel Systems Analysis Agency, Aberdeen Proving Ground	1
		COMBAT DEVELOPMENTS COMMAND	
☒	L2	Hq USA, Combat Developments Command, Ft. Belvoir	1
☒	G2	USACDC Air Defense Agency, Ft. Bliss	1
☒	G3	USACDC Armor Agency, Ft. Knox	1
☒	G4	USACDC Field Artillery Agency, Ft. Sill	1
☒	G5	USACDC Aviation Agency, Ft. Rucker	1
☒	G7	USACDC Chemical, Biological, and Radiological Agency, Ft. McClellan	1
☒	G11	USACDC Communications-Electronics Agency, Ft. Monmouth	1
☒	G12	USACDC Engineer Agency, Ft. Belvoir	1
☒	G13	USACDC Infantry Agency, Ft. Benning	1
☒	G16	USACDC Military Police Agency, Ft. Gordon	1
☒	G19	USACDC Transportation Agency, Ft. Eustis	1
☒	G20	USACDC Intelligence Agency, Ft. Huachuca	1
☒	G22	USACDC Nuclear Agency, Ft. Bliss	1
☒	G26	USACDC Special Operations Agency, Ft. Bragg	1
☒	G28	USACDC Maintenance Agency, Aberdeen Proving Ground	1
☒	L44	USACDC Concepts and Force Design Group, Alexandria	1
☒	L45	USACDC Systems Analysis Group, Ft. Belvoir	1
☒	L69	USACDC Intelligence and Control Systems Group, Ft. Belvoir	1
☒	O26	USACDC Strategic Studies Institute, Carlisle Barracks	1
☒	P2	USACDC Combat Systems Group, Ft. Leavenworth	1
☒	P3	USACDC Personnel and Logistics Systems Group, Ft. Lee	1
		SCHOOLS, US ARMY	
☒	G27	US Army Military Police, Ft. Gordon	1
☒	M17	US Army Ordnance, Aberdeen Proving Ground	1
☒	O2	US Army Air Defense, Ft. Bliss	1
☒	O3	US Army Armor, Ft. Knox	1
☒	O4	US Army Field Artillery, Ft. Sill	1
☒	O5	US Army Chemical, Ft. McClellan	1
☒	O6	US Army Engineer, Ft. Belvoir	1
☐	O7	US Army Finance, Ft. Benjamin Harrison	1
☒	O8	US Army Infantry, Ft. Benning	2
☒	O9	US Army Intelligence, Ft. Huachuca	1
☒	O10	Medical Field Service, Brooke Army Medical Center	1
☒	O11	US Army Command and General Staff College, Ft. Leavenworth	1
☒	O12	US Army Aviation, Ft. Rucker	1
☒	O16	US Army School, Europe	1
☐	C19	US Army Missile and Munitions Center and School, Redstone Arsenal	1

	Address code	Agency	Number of copies
☒	021	US Army Quartermaster, Ft. Lee	1
☐	023	US Army Institute of Military Assistance, Ft. Bragg	2
☒	024	US Army War College, Carlisle	1
☒	025	US Army Transportation, Ft. Eustis	1
☒	027	USMA, West Point	1
☐	029	US Army Adjutant General, Ft. Benjamin Harrison	1
☐	030	US Army Combat Surveillance School and Training School, Ft. Huachuca	1
☒	031	US Army Signal Center and School, Ft. Monmouth	1
☒	032	US Army Southeastern Signal School, Ft. Gordon	1
☐	033	USWAC School, Ft. McClellan	1
		MISCELLANEOUS ARMY (CONUS)	
☒	E34	US Army Intelligence Threat Analysis Detachment	1
☒	E37	Logistics Doctrine, Systems and Readiness Agency, New Cumberland Army Depot	1
☒	E38	Engineer Strategic Studies Group	1
☒	K11	US Army Logistics Management Center	2
☐	P9	US Army Strategy and Tactics Analysis Group	1
☐	R4	US Army Behavioral and Systems Research Laboratory	1
		US AIR FORCE	
☐	T4	Hq, US Air Force (AF/SAMID)	1
☐	T8	Air University Library, Maxwell Field	1
		US NAVY	
☐	S1	Chief of Naval Operations, OP-96	1
☐	S2	Chief of Naval Operations, OPO3EG-CNO	1
☐	S9	Naval War College, Newport	1
		US MARINE CORPS	
☒	S23	Marine Corps Development and Education Command, Quantico, Va.	1
		US GOVERNMENT AGENCIES	
☐	U1	Central Intelligence Agency	1
☐	U6	Department of State, Foreign Affairs Research Documents Center	3
☐	U9	Department of State, Office of Science and Technology	1
		DEFENSE CONTRACTORS AND UNIVERSITIES	
☒	C216	Center for Naval Analysis	1
☒	V2	Human Resources Research Organization, inc.	1
☒	V3	Institute for Defense Analyses	1
☒	V5	RAND Corporation	1
☒	V6	Center for Research in Social Systems	1
☒	V7	Stanford Research Institute	1
		FOREIGN GOVERNMENTS—BASIC STANDARDIZATION AGREEMENT COUNTRIES (Released through ST&A Division, OCRD)	
☐	L7	Supreme Headquarters, Allied Powers, Europe (USNMR)*	1
☒	W1	British Defense Research Staff	2
☒	W2	Canadian Defense Research Staff	2
☐	W3	North American Air Defense Command (US-Canadian HQ)	1
☐	W4	US Army Strategic Group—UK (for release to DOAE)	1
☒	W5	Australian Army Representative	2
☐	W6	US Delegation, UN Military Staff Committee	1

*Foreign Headquarters US Representative.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Research Analysis Corporation McLean, Virginia 22101	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Tactical Vehicle Pooling in the Corps/Army Service Area

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Report

5. AUTHOR(S) (First name, middle initial, last name)

Charles A. Allen
Bryce A. Frey
John W. Rakowski
Richard C. Rinkel, Project Director

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1972	197	10

8a. CONTRACT OR GRANT NO. DAHC19-69-C-0017 b. PROJECT NO. 011.156 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) RAC-R-143 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT "Distribution limited to US Government agencies only; Test and Evaluation; 5 May 72. Other requests for this document must be referred to HQDA (DAFD-SDS) Washington, D.C. 20310."

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Assistant Chief of Staff of the Army for Force Development

13. ABSTRACT

This study explores the concept of tactical vehicle pooling in the context of vehicle fleet planning and the potential reduction of vehicle requirements by means of serving users with pooled rather than organic vehicle fleets.

The scope of the effort is limited to the vehicles and units of a type corps/army service area and emphasis is upon development of analytical methods and their application. The tasks, organizational assignments, and operational modes of the corps/army service area fleet are explored for potential vehicle pooling situations. Methods of analyzing pooled versus current vehicle fleet performance are then developed and tested through a series of example problems including cargo/bulk fuel transport, maintenance vehicle operations, and containerization.

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Vehicle Pooling						
Tactical Vehicles						
Fleet Planning						
Logistics						
Simulation Methods						
Mobility						

UNCLASSIFIED

Security Classification